MACHINERY.

December, 1906.

THE NEW ENGINEERING BUILDING AT THE UNIVERSITY OF PENNSYLVANIA.

With the dedication of the Engineering Building of the University of Pennsylvania, of which a brief notice was given in the November issue of Machinery, a new and remarkable addition is made to the list of American technical laboratories. In describing the building and its equipment in the limited space it is possible to give to the subject in these columns, one hardly knows where to begin or what features to emphasize in a structure whose every feature has been the result of careful thought and long experience in the teaching of engineering subjects. Perhaps the best that can be done is to take a rapid survey of that part of the laboratory apparatus and those sections of the building which relate especially to subjects familiar to the readers of this paper.

The building itself is the largest of the seventy buildings now occupied by the University of Pennsylvania. It has a frontage of 300 feet, a depth of 210 feet and is three stories high, having in addition a large area of basement room available for laboratory and other school uses. The building is of fireproof construction. Direct steam heat is provided, with forced ventilation by electrically-driven fans; the lighting is by electricity. Rooms are provided for offices, mechanical, electrical and civil engineering laboratories, wood and iron working shops, forge shop and foundry, drafting rooms, class rooms, lecture room, assembly room, auditorium, engineering society room, museum and library. The exterior of the building is shown in Fig. 1.

Fig. 1. View from Southeast of Engineering Building of the University of Pennsylvania.

The mechanical laboratory is located on the ground floor of the building in the rear. It has a floor area of about 14,000 square feet. The apparatus is placed in groups, those relating to allied subjects being located together. In Fig. 2, which is taken from near the bend in the L-shaped area devoted to this department, the reader will get some idea of the engine equipment, although only a portion of it is shown. This comprises a Reeves vertical compound, an Ingersoll two-stage steam-driven air compressor, a Harrisburg 6 x 6 side crank engine, a 10 x 16 Porter-Allen engine, an 8 x 10 Ames engine, a 10 x 24 Hamilton Corliss engine, and a 10-horsepower Fairbanks slide valve engine. Various steam pumps, injectors, indicator test apparatus, pulsometers, etc., together with a full equipment of test instruments of all kinds, are provided. The various engines are each arranged for making tests and experiments of a certain variety; one is for steam consumption testing and another for brake horsepower tests, another for instruction in indicating, another for valve setting, etc. Two steam turbines, a 15-horsepower De Laval and a Curtis, the latter not yet in place, form part of the equipment. Dynamometers of various kinds, an elaborate hydraulic laboratory equipment and a number of gas engines fill the remainder of the floor space. A set of instruments for testing materials, shown in Fig. 3, is also located in this department. Three smaller testing rooms are equipped for experimenting and testing in the subjects of heating, ventilation and refrigeration. This equipment is large enough so that students are given individual work, the plan being to allow them all the freedom in their laboratory practice that they are capable of using intelligently.

There are five rooms in the building used for practical work in electricity, all of them with concrete floors and so arranged that each student can carry on experiments entirely independent of the rest of the class, so far as the use of the apparatus and the voltage experimented with is concerned. The instrument laboratory, shown in Fig. 4, is located on the same floor as the mechanical laboratory and has an equipment of tables and pedestals formed of solid concrete integral with the foundations, assuring entire freedom from vibration. The current supply for all the tables is regulated from four central switchboards, the mains and leads being conducted in underground passages. The direct current dynamo laboratory, part of which is shown in Fig. 5, has also a concrete floor provided with channels for the electrical connections. Floorplates of the construction shown are provided for holding the motors under test. The design is such that the vibrations produced by the machine are taken up in the wooden stringers laid on the concrete bases. Each of the testing floors has an instrument table on which the switches, rheostats, ammeters, etc., for each motor are placed. The power house of the building furnishes the main supply for the laboratory. Five hundred amperes are available at 110 volts. Six motors of various makes and five motor generator sets are included in the equipment. The alternating-current laboratory, located on the second floor, besides a number of alternating current motors and generators, is provided with two photometer rooms for the measurement of incandescent and other lights. One of the photometers is equipped with a Lummer-Podhun screen and the other with a Bunsen screen.

The work-shop course extends over the first two years of the student's course. He is taken in turn to the woodworking and pattern shop, the foundry, and then to the iron, machine, and forge shops. The woodworking shop is largely used in giving a preparatory instruction before entering the pattern shop. This latter contains an excellent selection of machinery suitable for the work required of it. The foundry is provided with ten large molding troughs, a coremaking equipment, two brass furnaces, a 22-inch cupola, pickling vat,

and a large space for bedding-in work. Students are thus given instruction in tempering sand, mixing loam, grinding, facing, tumbling and pickling, casting, making gaggers and cores, daubing up the cupola, and operating the brass furnace. Loam molding, dry and green sand molding, bench work, floor work, and swept-up work are all included in the course.

The machine shop equipment, of which a portion is shown in Fig. 6, comprises the machines shown, together with drill presses, cutter grinders, tool grinders, a large number of lathes, planers, power saws, screw machines, etc. The course of instruction in the shop is intended to give the student a clear enough understanding of machine shop methods to fit him to design and supervise the construction of the machinery he will have to do with later in his life. An acquaintance with shop literature, including the technical papers relating to the subject, is insisted on, and a prescribed amount of reading is assigned for each month on which notes are made and credit is given. The forge shop, Fig. 7, is equipped with Buffalo down-draft forges, a 250-pound steam hammer with a large forge, and a suitable outfit of blowers, exhaust fans, punching machines, shears, pipe-threading machinery, etc.

The drafting rooms are located on the north side of the building on the second and third floors and cover a space of 11,800 feet. Instruction in this subject continues throughout the four years of the course and is carried on through an ingenious system of individual exercises, commencing with instruction and practice in the scaling of dimensions and the use of the instruments, to final problems involving the design of a complete machine. The instruction cards for the various exercises are so arranged that each student is doing work unlike that of his neighbor, so that he has to study out for himself the principles of the problem set before him. The last problem in the course is usually the design of a crane, a task which involves knowledge of about all the student has studied during his four years at the University. In this case, also, each student has a problem of his own, and has to work out the arrangement of the parts and their dimensions as best he can.

The civil engineering equipment, located at the east end of the building, has, as one of its features, a material-testing laboratory equipped with autographic machines of various types and sizes, from the 1,500-pound wire-testing machine to the 600,000-pound Olsen vertical machine, the latter under contract but not yet installed. A 200,000-pound machine of this make is shown in Fig. 8. The cement laboratory, equipped by Robert Lesley of the class of '71, has elaborate provisions for individual work in the study of problems relating to plain and reinforced concrete construction. Perhaps the feature of greatest interest to the mechanical engineer, in the civil engineering section, is the hydraulic laboratory which occupies rooms in the basement and on the first and second floors in the rear of the building. The apparatus is too varied and too elaborate in its arrangement to permit an extended description, so only the salient features will be noted.

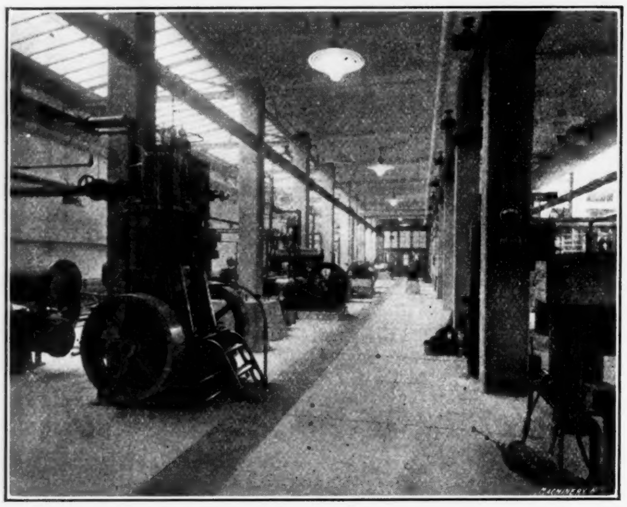
Fig. 2. An Aisle in the Steam Engineering Laboratory.

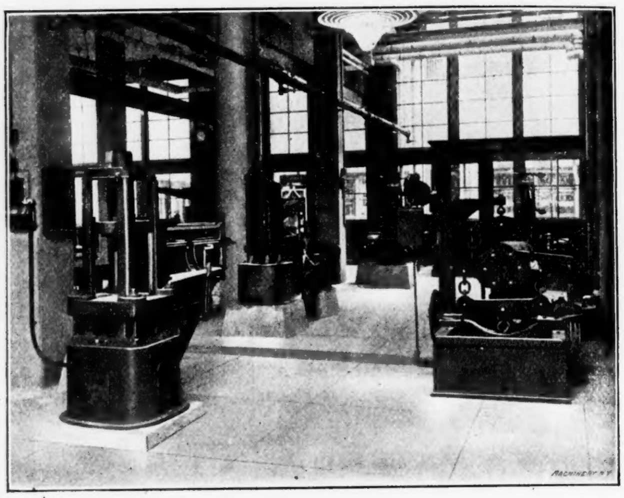
Fig. 3. Testing Machine Equipment of the Mechanical Laboratory.

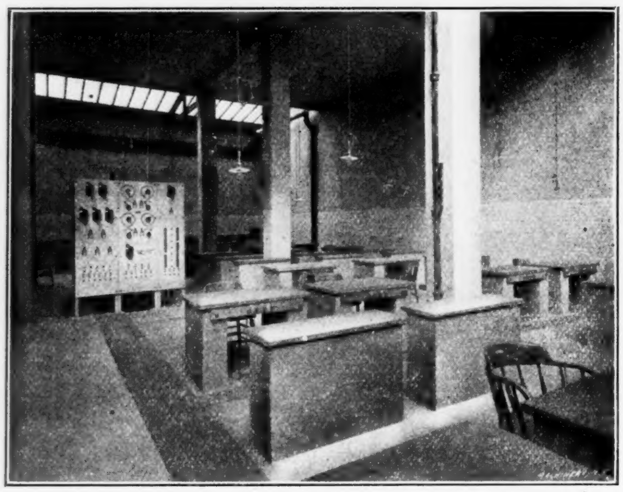
Fig. 4. Electrical Instrument Laboratory, showing Design of Pedestals and Tables.

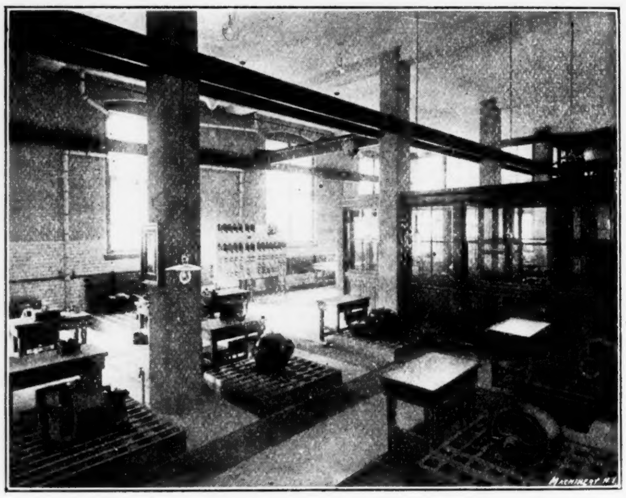
Fig. 5. Motor and Dynamo Testing Laboratory.

The supply of water for the hydraulic experiments undertaken in this laboratory is contained in a tank under the basement floor. This tank is made of concrete and has a capacity for 23,000 gallons. In one corner an 8-inch tubular well has been driven to a depth of 110 feet. This is to be used in efficiency tests and experimental work with deep-well pumps, etc. A battery of three electrically-driven two-stage Worthington centrifugal pumps, shown in Fig. 9, takes the water from this tank and delivers it in any desired volume, and, within the limits of speed control of the motors, with any desired head to either or both of the two pressure mains of 10-inch cast iron pipe shown supported on brackets on the wall. Independent of the speed regulation of the pumps,

there are two methods of regulating the pressure in the mains, either by a free discharge which may be throttled to any desired degree, thus giving a constant pressure, or by connecting the main with the 65-foot standpipe, the lower end of which is seen at the extreme left of Fig. 10. This pipe runs through to the top of the building and is provided with a number of overflows, any one of which may be used. The pressure mains are supported near the ceiling of the basement room and the floor above it as well, and are provided at frequent intervals with gate valves and flanged openings for the attachment of any apparatus it may be desired to use. The two pipes may be operated independently at different pressures. The use of centrifugal pumps insures a steadiness of delivery and ease of control not attainable with reciprocating pumps.

A pressure tank, whose conical base is seen in Fig. 10, extends from the basement through to the top of the second story. It may be connected with the standpipe or directly to either of the pumps. The conical base allows a gradual decrease in the velocity of the entering water which assures a freedom from local eddies and pressure disturbances in the interior. On the first- and second-story floors provision is made for attaching orifices of various shapes to the pressure tank, the orifice aperture on the first floor discharging into the left-hand of the two weir tanks shown in Fig. 11. The orifice device is of unusual and interesting construction. It is set in a bronze casting whose inner surface is smooth and flush and offers no impediment to the free movement of the water. A disk valve operated by a wrench on the projecting stud may be turned to close the inner face of the aperture, when the orifice plate may be removed and exchanged without having to empty the pressure tank. The orifice holder itself has an interrupted thread on its periphery which allows it to be advanced through the opening in the disk gate so that its inner surface is flush with that of the disk.

The two weir tanks shown in Fig. 11 are 34 feet long with a cross-section of 5 x 5½ feet. One of them, as shown, is provided with a floorplate covering. They may be connected for volumetric measurements if desired, giving a total capacity of 13,000 gallons. A convenient pit is provided for the hook gages, where they will not be disturbed by the momentary changes in the level of the water. The water is introduced through T's drilled full of perforations directed against the back wall. One of these T's is shown at the end of the tank in Fig. 11. The tanks are provided with suitable baffle plates, and have outlet valves at the bottom operated by the cross shafts and levers shown in the cut. The ends of the tank are arranged to be fitted with measuring weirs of various sizes, with submerged orifices, or the end may be opened entirely, making the tank a canal for the study of various forms of dam sections, etc. Weighing tanks in the basement, which may be seen in Fig. 9, are mounted on trucks to be wheeled under the ends of these weir tanks when necessary. Hydraulically-controlled valves shift the discharge water from one tank to the other as each is filled.

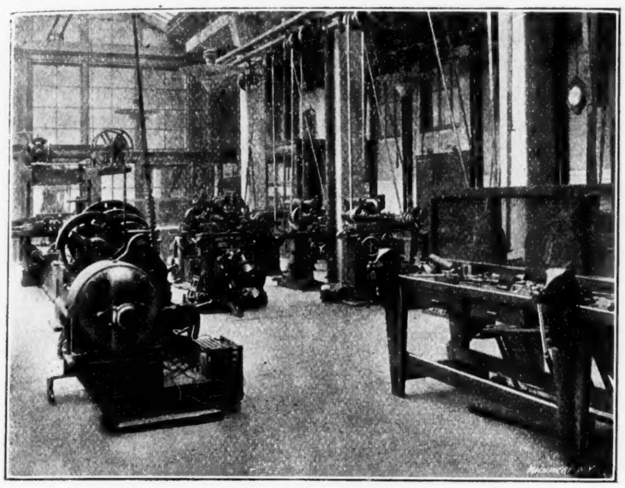

Fig. 6. A Corner of the Machine Shop.

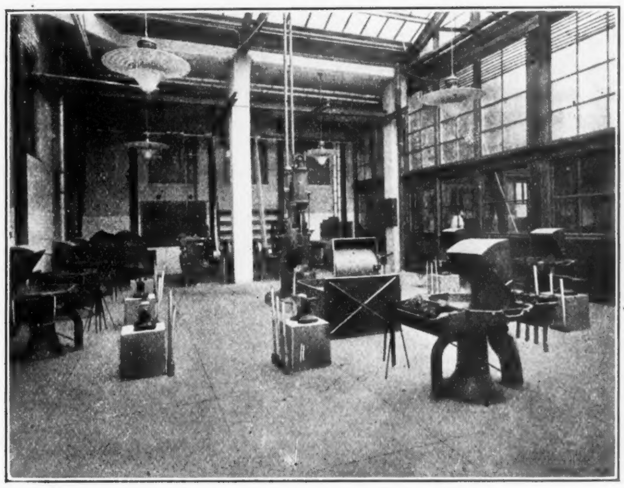

Fig. 7. Down-draft Forges and Steam Hammer.

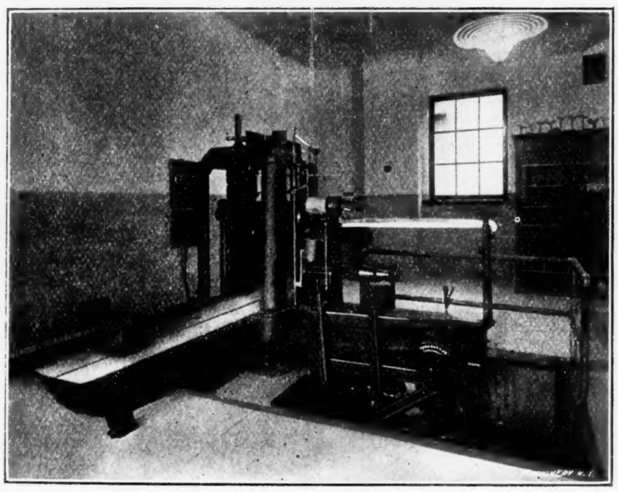

Fig. 8. 200,000-pound Universal Testing Machine in Civil Engineering Laboratory.

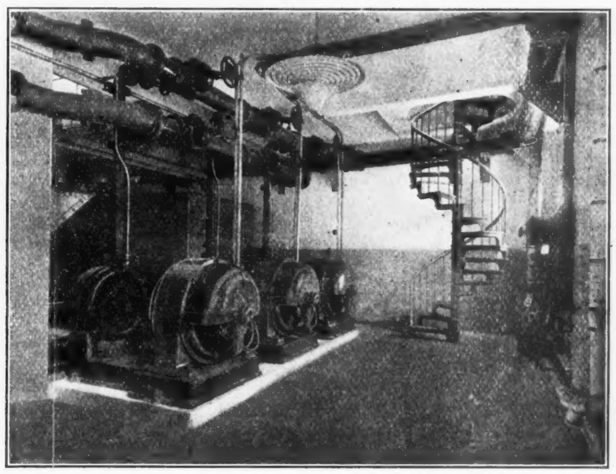

Fig. 9. Turbine Pumps for Hydraulic Laboratory Service.

A 9-inch turbine and a 12-inch reaction wheel form part of the installation. Additional apparatus for special investigation and research is to be added to the equipment as occasion requires.

As before intimated, what is here illustrated and described is but a very small part of what the visitor can see in a visit to the building, and of what he can learn from conversation with the professors and instructors as to the methods employed in using the apparatus, and the ideas and ideals which determine the course of instruction followed in the institution. So far as the equipment and arrangement of the building is concerned one cannot but be impressed with the thoroughness with which every detail has been worked out. Prof. Spangler, of the department of mechanical and electrical engineering, and Prof. Marburg, of the department of civil engineering are the men responsible for the design of this new Engineering Building of the University of Pennsylvania.

THE DESIGN OF BEARINGS.—1.

FRICTION OF JOURNALS.

FORREST E. CARDULLO.

The design of journals, pins, and bearings of all sorts is one of the most important problems connected with machine construction. It is a subject upon which we have a large amount of data, but, unfortunately, they are very conflicting. The results obtained from the rules given by different mechanical writers will be found to differ by 60 per cent or more. Many of our best modern engines have been designed in defiance of the generally accepted rules on this subject, and many other engines, when provided with what were thought to be very liberal bearing surfaces, have proved unsatisfactory. The writer believes that this confusion has been the result of a misconception of the actual running conditions of a bearing.

A journal should be designed of such a size and form that it will run cool, and with practically no wear. The question both of heating and wear is one of friction, and in order for us to understand the principles upon which the design of bearings should be based, we must first understand the underlying principles of friction. Friction is defined as that force acting between two bodies at their surface of contact, when they are pressed together, which tends to prevent their sliding one upon the other. The energy used in overcoming this force of friction, appears at the rubbing surfaces as heat, and is ordinarily dissipated by conduction through the two bodies. The force of friction, and hence the amount of heat generated under any given circumstances, can be greatly reduced by the introduction of an oily or greasy substance between the rubbing surfaces. The oil or grease seems to act in the same way that a great number of minute balls would, reducing the friction and wear, and thus preventing the overheating and consequent destruction of the parts. On this account, bearings of all kinds are always lubricated. Thus the question of journal friction involves the further question of lubrication.

For the purpose of understanding as far as possible what goes on in a bearing, and the amount and nature of the forces acting under different conditions, several machines have been designed to investigate the matter. In general they are so arranged that a journal may be rotated at any desired speed, with a known load upon the boxes. Suitable means are provided for measuring the force of friction, and also the temperature of the bearing. Provided with such an apparatus, we find that the laws of friction of lubricated journals differ very materially from those commonly stated in the textbooks as the laws of friction. A comparison of the two will prove interesting.

It is generally stated in the textbooks that the force of friction is proportional to the force with which the rubbing surfaces are pressed together, doubling, or trebling, as the case may be, with the normal pressure. This law is perfectly true for all cases of unlubricated bearings, or for bearings lubricated with solid substances, such as graphite, soapstone, tallow, etc. When, however, the bearing is properly lubricated with any fluid, it is found that doubling the pressure does not by any means double the friction, and when the lubricant is supplied in large quantities by means of an oil bath or a force pump, the friction will scarcely increase at all, even when the pressure is greatly increased. From the experiments of Prof. Thurston, and also of Mr. Tower, it appears that the friction of a journal per square inch of bearing surface, for any given speed, is equal to

$$f = kp^n \qquad (1)$$

where f is the force of friction acting on every square inch of bearing surface, p is the normal pressure in pounds per square inch on that surface, and k is a constant. The exponent n depends on the manner of oiling, and varies from 1 in the case of dry surfaces, to 0.50 in the case of drop-feed lubrication, 0.40 or thereabout in the case of ring- and chain-oilers and pad lubrication, and becomes zero in case the oil is forced into the bearing under sufficient pressure to float the shaft.

The second law of friction, as generally stated, is that the force of friction is independent of the velocity of rubbing. This law also is true for unlubricated surfaces, and for surfaces lubricated by solids. In the case of bearings lubricated by oil we find that the friction increases with the speed of rubbing, but not at the same rate. If we express the law as an equation, we have

$$f = kv^m, \qquad (2)$$

where f is the force of friction at the rubbing surfaces in pounds per square inch, k is a constant, v is the velocity of rubbing in feet per second, and the exponent m varies from zero in the case of dry surfaces to 0.20 in the case of drop feed, and 0.50 in the case of an oil bath.

The third law of friction, as it generally appears in the textbooks, is that the friction depends, among other things, on the composition of the surfaces rubbed together. This, again, while true for unlubricated surfaces, is not true for other conditions. It matters nothing whether the surfaces be steel, brass, babbitt, or cast iron, so long as they are perfectly smooth and true, they will have the same friction when thoroughly lubricated. The friction will depend upon the oil used, not on the materials of journal or boxes, when the other conditions of speed and pressure remain constant. Many people think that babbitt has a less friction than iron or brass, under the same circumstances, but this is not true. The reason for the great success of babbitt as an "anti-friction" metal depends upon an entirely different property, as will appear later.

Combining into one equation the different laws of the friction of lubricated surfaces, as we actually find them to be, we have

$$f = kp^nv^m \qquad (3)$$

where f is the force of friction at the rubbing surface in pounds per square inch, k is a constant which varies with the excellence of the lubricant from 0.02 to 0.04, and the other quantities are as before. From this expression, we see that

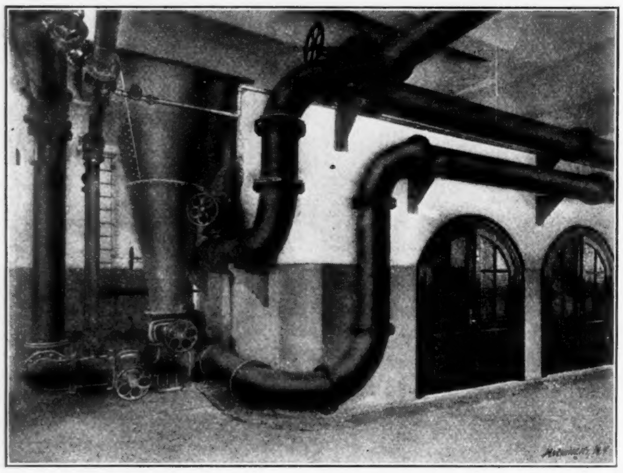

Fig. 10. Base and Water Connection of Stand-pipe and Pressure Tank.

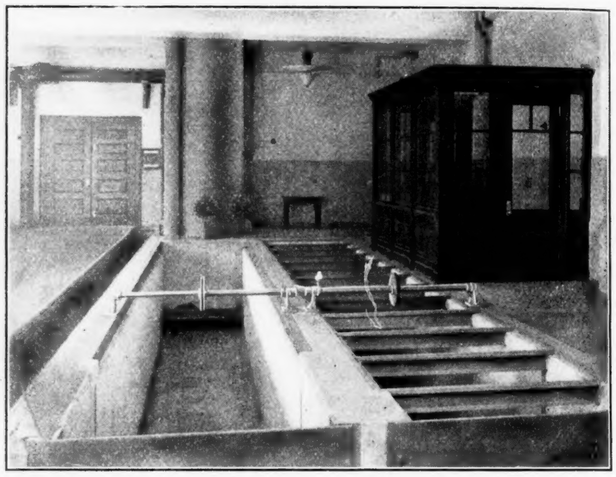

Fig. 11. Pressure Tank and Orifice Discharging into Measuring Tanks.

the friction increases with the load on the bearing, and also with the velocity of rubbing, although much more slowly than either.

The quantity of heat generated per square inch of bearing area, per second, is equal to the force of friction, times the velocity of rubbing. All of this heat must be conducted away through the boxes as fast as it is generated, in order that the bearing shall not attain a temperature high enough to destroy the lubricating qualities of the oil. The hotter the boxes become, the more heat they will radiate in a given time. When the bearing is running under ordinary working conditions, it will warm up until the heat radiated equals the heat generated, and the temperature so attained will remain constant as long as the conditions of lubrication, load, and speed do not change. This rise in temperature above that of the surrounding air, varies from less than 10 to nearly 100 degrees Fahrenheit, and is commonly about 30 degrees. We must keep either the force of friction, or the velocity of rubbing, or both, down to that point where the temperature shall not attain dangerous values. As has been shown in the preceding paragraphs, it was formerly believed that the force of friction was equal to a constant times the bearing pressure, and therefore, that the work of friction was equal to this constant times the pressure, times the velocity of rubbing. Now, since it is the work of friction that we are obliged to limit to a certain definite value per square inch of bearing area, it was concluded that a bearing would not reach a dangerous temperature if the product of the bearing pressure per square inch and the velocity of rubbing did not exceed a certain value. Accordingly we find Prof. Thurston's formula for bearings to be

$$p\,v = C. \qquad (4)$$

where p is the bearing pressure in pounds per square inch, v is the velocity of rubbing in feet per second, and C has values varying from 800 foot-pounds per second in the case of iron shafts to 2,600 in the case of steel crankpins. This has long been the standard formula for designing bearings, and while it is not satisfactory in extreme cases, it is very satisfactory for bearings running at ordinary speeds.

Turning our attention again to the results obtained from the machines for testing bearings, we find that while the results are very even and regular for ordinary pressures and temperatures, when we begin to increase either of these to a high point, the friction and wear of our bearing suddenly increases enormously. The reason is that the oil has been squeezed out of the bearing by the great pressure. This squeezing out of the oil, and consequent great increase in the friction, has three effects. The absence of the lubricant causes the parts to scratch or score each other, thus rapidly destroying themselves, the great increase in friction results in a sudden very high temperature, in itself destructive to the materials of the bearing, and the heating is generally so rapid as to cause the pin and the interior parts of the box to expand more rapidly than the exterior parts, thus causing the box to grip the pin with enormous pressure. When the oil has been squeezed out in this manner, the bearing is said to seize.

It is evidently of advantage to make the bearing of such material that the injury resulting from seizing shall be a minimum. If the shaft and box are of nearly equal hardness, each will tend to scratch the other when seizing occurs, and the scoring is rapid and destructive. This action will be especially noticed in case the shaft has hard spots in it, while the rest is comparatively soft, as is the case in the poorer grades of wrought iron. If, however, the shaft is made of a hard and homogeneous material, like the better grades of medium steel, and the bearing is made of some soft material, like babbitt, the bearing will not roughen the journal, and so the journal cannot cut the bearing. This is the first reason why babbitt bearings are so successful.

A second reason for the success of babbitt bearings lies in the fact that they cannot be heated sufficiently to make the bearing grip the journal. They will rather soften and flow under the pressure without actually melting away, just as iron and steel soften at a welding heat. The harder bearing metals, such as brass and bronze, do not have these advantages, and have been almost entirely replaced by babbitt in bearings for heavy duty, especially when thorough lubrication is difficult.

Babbitt is a successful bearing metal for still a third reason. The unit pressure on any bearing is not the same at all points. The shaft is invariably made somewhat smaller in diameter than the box. If there is a high spot on the surface of the box, that spot will have a very large proportion of the total pressure acting on it, and as a result the film of lubricant will be broken down at that point, and local heating and consequent damage result. In the case of babbitt bearings, before the damage can become serious the metal is caused to flow away from that point under the combined influence of the heat and pressure, the oil film is again established, and normal conditions restored.

The unit pressure which any bearing will stand without seizing depends upon its temperature and the kind of oil used. The lower the temperature of the bearings, the greater the allowable unit pressure. The reason for this is that oils become thinner and more free-flowing at the higher temperatures, consequently they are more easily squeezed out of the bearing, and it is more likely to seize. On this account, the higher the velocity of rubbing, the less the unit pressure that can be carried, but it does not follow that the allowable unit pressure varies inversely as the speed of rubbing, as was formerly thought.

The thicker and less free-flowing an oil is, the greater the unit pressure it will stand in a bearing without squeezing out. A watch oil, or a very light spindle oil, will only run under a very small unit pressure; sometimes they are squeezed out of the bearing when the pressure does not exceed 50 pounds per square inch. On the other hand, a cylinder oil of good body will stand a pressure of over 2,000 pounds to the square inch in the same bearing. There is a certain quality of oil which is best adapted to every bearing, and if possible it should be the one used.

A third cause influencing the pressure which may be carried is adhesiveness between the oil and the rubbing surfaces. Some oils are more certain to wet metal surfaces than are others, and in the same way, some metals are more readily wet by oil than are others. It is evident that when the surfaces repel, rather than attract the oil, the film will be readily broken down, and when the opposite is the case the film is easily preserved.

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The average fire loss in the United States is more than $2.00 per capita as compared with only 33 cents per capita in six of the leading European countries. Such an enormous difference cannot be accounted for simply by referring to the greater average wealth in the United States causing a greater loss in dollars and cents for fire of the same magnitude. It must be to some extent accounted for, also, on the ground of less rigid building laws in this country which do not require a builder of houses to comply so strictly with the requirements of safety. This fact ought to be carefully considered as the yearly fire loss if cut down to the same proportion, considering the country's average wealth, as in Europe, would mean a saving of a hundred millions to this country every year. In this connection it is of interest to note that according to the International Society of Building Commissioners and Inspectors only one of the 11,500,000 buildings in this country is absolutely fireproof. This one is a testing laboratory constructed at Chicago in the interests of the leading fire insurance companies. There are only 4,000 buildings in the country which are even nominally fireproof, and these can be damaged in a conflagration to the extent of from 30 to 90 per cent of their value. The opinion of the commissioners and inspectors may, of course, be somewhat pessimistic and contain an exaggeration, but the figures as to comparative loss in this country and Europe give additional weight to their statement. Another fact not to be lost sight of is that the insurance rates are in no case in United States less than twice as large as they are under the same conditions in Northern Continental Europe. That here is a chance for improvement in which everyone should be interested and active is beyond question.

FLANGE BOLTS.

JOHN D. ADAMS.

Some time ago I had occasion to figure on the number and size of bolts necessary to hold down a pillar crane. After giving the matter a little thought I soon realized that there was a great deal more to the problem than I had at first supposed. The illustrations herewith, Figs. 1 to 3, show three examples of bolts used in this manner—that is, a series of bolts equally spaced around a circular flange intended to resist overturning. The first shows a pillar crane where the load has a tendency to overturn the pillar; the second a radial drill where the pressure on the drill has a tendency to overturn the column and the third a self-supporting chimney where the wind pressure has an overturning effect. As I was unable to find anything in any of the hand books at my disposal relating to bolts used in this connection, I interested myself in the problem long enough to learn that it was of such a nature as to preclude any general and yet simple formula.

It will be noted that there are two elements—one of tension due to the strain in the bolts and one of compression due to the compression set up in the foundation. To exaggerate matters, suppose we were to place a layer of soft wood between the flange of the crane and the foundation. It is evident that the load would have a tendency to stretch the bolts on the side opposite the load and also to sink that part of the flange nearest the load, into the wood as in Fig. 1. The neutral axis would be a line drawn through the point where the flange and the foundation separate and at right angles to the axis and later look into the factors that control the position of this axis.

Referring to Fig. 4 it will be evident that the amount each bolt is stretched, and therefore the stress it exerts, varies directly as its distance from the neutral axis. It will be further noted that the moment of any one bolt as regards the neutral axis is directly proportional to its distance from this axis. Therefore the moment of any bolt or the product of the force it exerts, and the distance through which it acts, is directly proportional to the square of its distance from the neutral axis. Consequently if we could easily determine the value of the mean square, as we surely can, we will then only have to multiply it by the number of bolts to obtain the sum of the squares.

Consider six bolts as in Fig. 8 spaced equidistant on a circle of radius = 1. Let the maximum stress in any bolt be 8,000 pounds and take the neutral axis as being tangent to the bolt circle. Hence we have the following:

TABLE I. SIX BOLTS.

Bolt No.	Distance.	Square of Distance.	Stress.	Moment.
1..........	2.00	4.00	8,000	16,000
2..........	1.50	2.25	6,000	9,000
3..........	.50	.25	2,000	1,000
4..........	....	....	.....	......
5..........	.50	.25	2,000	1,000
6..........	1.50	2.25	6,000	9,000
Totals......	....	9.00	.....	36,000

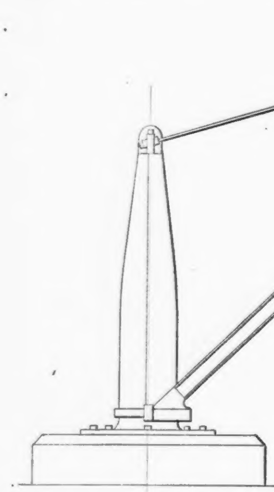


Fig. 1. Jib Crane: Load has a Tendency to Overturn.

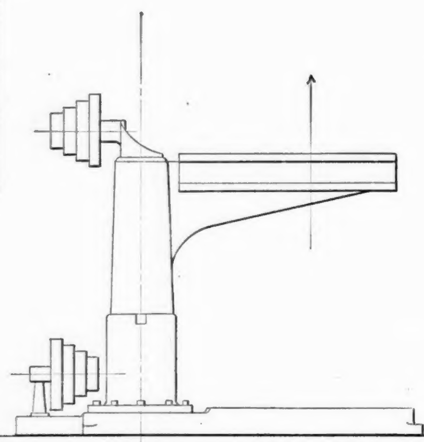


Fig. 2. Radial Drill: Pressure of Feed Tends to Overturn.

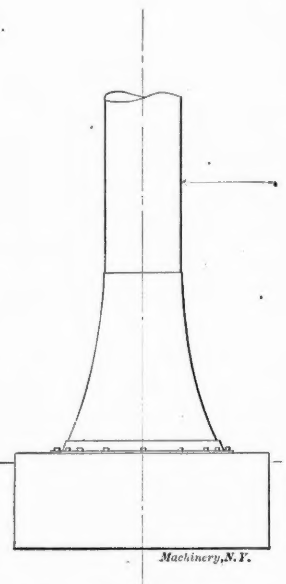


Fig. 3. Wind Pressure Tends to Overturn Chimney.

direction of the load. On one side of this line we have the compression element due to the foundation, the bolts on this side having no value whatever. Starting at this neutral line and running the other way we note that each bolt has a different value. To find the total value of the bolts, which constitutes our problem, we must add up these different values and in consequence must know the position of the neutral axis.

If instead of coming in contact with the foundation or bed-plate, the flange was supported by studs as shown in Fig. 5, we would have half of the studs in compression and the other half in tension and the neutral axis would pass through the center of the bolt circle. If the flange had an annular surface inside of the bolts upon which to rest, as in Fig. 6, the neutral axis would lie somewhere inside of the larger circumference of this annular bearing surface as indicated. If conditions were as in Fig. 7, the neutral axis would be somewhere between the bolt circle and the outside circumference of the flange or possibly tangent thereto. Let us first determine the total bolt values for certain given positions of the neutral

This gives a value for the mean square 9.00 ÷ 6 = 1.50. If the radius were twice as great, the mean square would, of course, be four times as great. This table, therefore, indicates that the

$$\text{Mean square} = 1.50\,R^2 = \tfrac{3}{8}\,D^2 \qquad (1)$$

The total of these square values represents the moment of inertia of the set of bolts and if we multiply the sum by the maximum stress and divide it by the distance of the point at which that stress acts, viz., D, we obtain the moment of resistance just as we do in figuring the strength of a beam in flexure. Hence we have the following:

Moment of inertia = No. of bolts × mean square = $1.50\,R^2N = \tfrac{3}{8}\,D^2N$ and

$$\text{Moment of resistance} = \frac{1.50\,R^2\,N\,S}{D} = \tfrac{3}{8}\,N\,D\,S \qquad (2)$$

where S is the maximum total stress in any bolt.

Applying this to Fig. 8 we have $\tfrac{3}{8} \times 6 \times 2 \times 8{,}000 = 36{,}000$, which is verified by above table where the moment of each bolt is computed separately.

Similarly we may take twelve bolts, and considering the

maximum stress on any bolt is 8,000, the distance to and stress in each bolt are as follows:

TABLE II. TWELVE BOLTS.

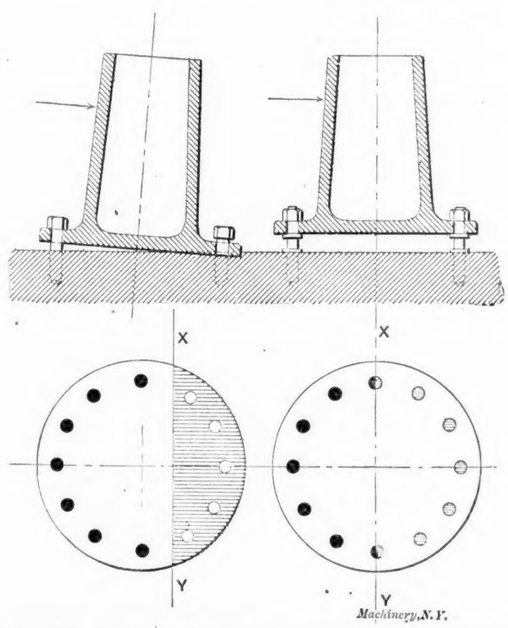
Bolt No.	Distance.	Square of Distance.	Stress.	Moment.
1..........	2.000	4.000	8,000	16,000.0
2..........	1.866	3.482	7,464	13,928.3
3..........	1.500	2.250	6,000	9 000.0
4..........	1.000	1.000	4,000	4,000.0
5..........	.500	.250	2,000	1,000.0
6..........	.134	.018	536	71.8
7..........	.....	.....	.....	....
8..........	.134	.018	536	71 8
9..........	.500	.250	2,000	1,000.0
10..........	1.000	1.000	4,000	4,000.0
11..........	1.500	2.250	6,000	9,000.0
12..........	1.866	3.482	7.464	13,928.3
Totals.. ...	.....	18.000	.....	72,000.2

By equation 2 we have Moment $= \frac{3}{8} N D S = \frac{3}{8} \times 12 \times 2 \times 8{,}000 = 72{,}000$, which agrees with result found by computing moment of each bolt separately as above table shows. The value of the mean square is by equation (1) equal to $1.5 R^2$, which in this case $18 \div 12 = 1\frac{1}{2}$. This table then verifies our formulas for both mean square and total moment exerted by the twelve bolts.

For twenty-four bolts the results are the same, and the following table is given to show that the formulas are applicable to a large number of bolts.

TABLE III. TWENTY-FOUR BOLTS.

Bolt No.	Distance.	Square of Distance.	Stress.	Moment
1	2.000	4.000	8 000	16,000
2-24.......	1.966	3.865	7 864	15 461
3-23.......	1.866	3.482	7,464	13.928
4-22.......	1.707	2.914	6,828	11,655
5-21.......	1.500	2.250	6,000	9,000
6-20.......	1.259	1.585	5,036	6.340
7-19.......	1.000	1.000	4,000	4 000
8-18.......	.741	.549	2,964	2,196
9-17.......	.500	.250	2 000	1,000
10-16.......	.293	.086	1,172	343
11-15.......	.134	.018	536	72
12-14.......	.034	.001	136	5
Totals......	.	36.000	....	144,000



Figs. 4 and 5. Location of Neutral Axis Under Varying Conditions.

Moment $= \frac{3}{8} N D S = \frac{3}{8} \times 24 \times 2 \times 8{,}000 = 144{,}000$.

Mean square $1.5 R^2 = \dfrac{36}{24} = 1.5$.

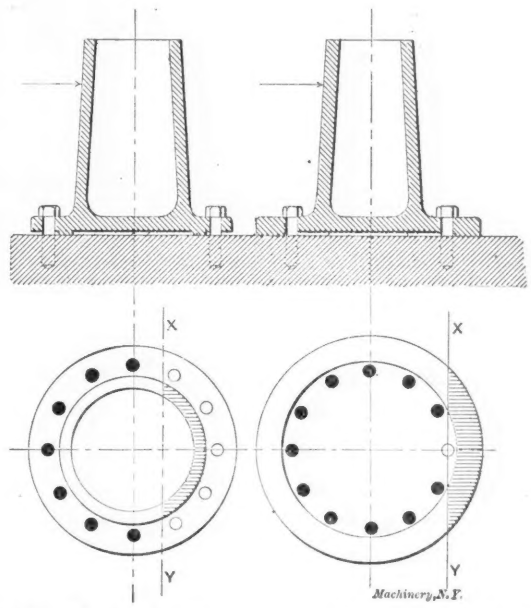
The foregoing applies only where the neutral axis is tangent to the bolt circle, but knowing what the moment of a series of bolts is when the neutral axis is in this position, it is a simple matter to determine the moment for any other known position.

Referring to Fig. 10, let the neutral axis have the position $x y$. It will be evident that the moment depends upon the mean square of a series of distances, which are composed of two parts, viz., a constant ϕ and a variable such as a, b, c, d. Hence for the total of the squares we have

$$(\phi + 0)^2 + (\phi + a)^2 + (\phi + b)^2 + (\phi + c)^2 + \ldots$$

which may be written $N\phi^2 + 2\phi\,(a + b + c + \ldots) + a^2 + b^2 + c^2 + \ldots$

Referring to Fig. 10 it will be seen that the average of 0 and f = radius; a and e = radius; b and d = radius, etc., which



Figs 6 and 7. Location of Neutral Axis under Varying Conditions.

means that the sum of $a + b + c + \ldots = N R$, which may be written for the second term of the above expression. For the third term we may write $a^2 + b^2 + c^2 + \ldots = \frac{3}{8} N D^2$ by equation (1) which we have already obtained.

Hence we may write for the sum of the squares

$$N\phi^2 + N\phi D + \tfrac{3}{8} N D^2.$$

To obtain the moment of resistance we must divide this by the distance of the point of maximum stress from the neutral axis and multiply it by the maximum stress. Therefore

$$\text{Moment of Resistance} = \frac{N\,(\phi^2 + \phi D + \frac{3}{8} D^2)\,S}{\phi + D} \qquad (3)$$

When the neutral axis lies inside of the bolt circle we have $(0 - \phi) + (a - \phi) + (b - \phi) + (c - \phi) + \ldots$ which may be written $N\phi^2 - 2\phi\,(a + b + c + \ldots) + a^2 + b^2 + c^2 + \ldots$ and for moment we have

$$\text{Moment of resistance} = \frac{N\,(\phi^2 - \phi D + \frac{3}{8} D^2)\,S}{\phi + D} \qquad (4)$$

The only remaining factor to determine is the position of the neutral axis so that we can apply the above formula. In the first place it would be well to point out certain conditions that render this somewhat uncertain. In these, as in most all bolt calculations, the initial strain set upon a bolt by tightening the nut cannot be definitely determined. Then again the assumption that each bolt is strained directly in proportion to its distance from the neutral axis necessitates that the flange be absolutely rigid. While a heavy cast iron flange with a large fillet and possibly a few stiffening ribs, is about as rigid as anything we might find in construction work, yet it is not absolutely rigid. Finally we might mention the weight of the structure or pillar that is borne by the flange. This factor has a tendency to increase the element of compression and decrease the element of tension to a slight extent.

It is, however much more practical and advisable to determine the position of the neutral axis as closely as possible than to attempt to determine these several uncertain quanti-

ties. The formula will at best give uniformity of results and if experience points out that our results are correct in one case, they will also be correct for other cases when they apply to similar conditions.

It is an accepted fact that in all cases of flexure the neutral axis passes through the center of gravity of the section. This means that in Figs. 4, 5, 6, and 7 the shaded area in compression on one side of the line would exactly balance the movement of the bolt axes on the other side, provided of course that the same material were used throughout. It would therefore seem that the practical method to locate this neutral axis would be to lay out the bolts and that part of the flange in contact with the foundation and find the centre of gravity, making allowance for the fact that the weight per unit of area of tension and compression areas should be taken as proportional to their respective stresses per square inch.

* * *

A STEP TOWARD INCREASED FACILITIES FOR INDUSTRIAL EDUCATION.

The State of Massachusetts has, not without reason, taken pride in claiming itself the foremost State in the Union in educational matters. At the present time, when the question of industrial training has been brought to the front, that State is evidently determined to continue to hold its own, and the progress made so far is indicative of great and lasting results. Not long ago a commission was appointed by the State to investigate the needs for organized facilities for industrial education, and also to report upon the possibilities for establishing such institutions as may be needed. This commission, it appears, has made thorough research at home as well as abroad, and there are good reasons to expect that the State will before long take steps in the direction of inaugurating a system of trade education based upon the principles employed in Germany, but perfected to meet American requirements and conditions.

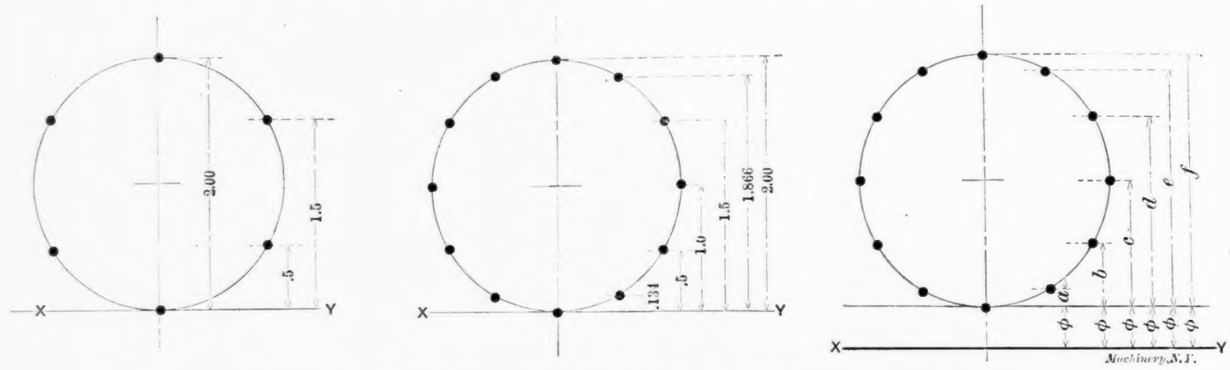
The individual cities of the State, however, have not been inactive, expecting the State to act, but have themselves taken steps to partially solve a problem which is conceded to be one of the more important ones in connection with the future of American industries.

In the city of Springfield there was opened, in September, an educational institution called the Technical High School, which is intended to give instruction of a kind not hitherto obtainable in that city. While schools of this character are not entirely unknown in this country, the one referred to is claimed to be the largest of its kind, and the one most completely organized to meet industrial needs. It is intended for pupils of the same age as attend the regular high schools, and has accommodations for as high a number of pupils as nine hundred. The curriculum of the school will embrace three courses. One of these is of a more general character, giving a general high school education, but necessarily embracing some mechanical subjects and mechanical drawing. The other two courses are purely technical in their nature, but differ as to the purpose of the instruction given. The one will prepare for the entering of higher technical institutions, and will give a thorough course in all elementary technical matters. In fact, it will undoubtedly be found that a great number of pupils after having finished this course will be able to enter directly into the industrial field in secondary positions, and that they, after gaining necessary practical experience, will find themselves well equipped for the future.

The second of the two courses purely technical will prepare the pupils directly for practical life, and will be what is usually termed a trade school. While this course will, evidently, give ample instruction in all the elements of theoretical technical matters, more particular stress will be laid upon practical training. After a term of four years the pupils of this course will be able to enter the mechanical trades with a great advantage over those who have merely intended to gain all their training through an apprenticeship.

Practical shop work will be required to a great extent in all the courses, and the school is equipped with excellent facilities in this respect. There is a machine shop, a blacksmith shop, a pattern shop and a foundry. There will also be given instruction in plumbing, ordinary joinery and in wood finishing. Particular stress will be laid upon the subject of mechanical drawing, and the drawing room of the school is claimed to be the largest of any school or college in the country. As many of the pupils will in all probability enter the drawing rooms of our industrial establishments directly after having finished their course, or at least without any further training in mechanical drawing, it is a most important point that the instruction in mechanical drawing be thorough and complete. The average draftsman of the younger class who to-day enters the shop drawing room lacks to a perceptible degree the understanding of theoretical principles as well as practical requirements, due in a large measure to the superficial training imparted to him during a few months' course in an evening school or through the mails from a correspondence school. This is not said with the view of diminishing the regard for the correspondence schools, many of which have filled a want in the past and will probably continue to do so in the future. There are men who cannot obtain their training in any other manner, and that the correspondence schools have filled a need is amply indicated by the enormous success of at least one of these institutions.

Whether from an educational point of view it is desirable for those who intend to acquire a higher technical education to specialize at as early an age as the one when entering the high school, may be open to discussion. Wherever possible, a special technical education ought to be resting upon a foundation of a good general education. There are many things necessary to the man who expects to advance in life beyond the narrow limits of the average draftsman or mechanic. He needs a general idea of a few things besides trigonometry and gearing, and the best time for him to lay the foundation to this education is before entering the particular school which is intended to give him his special technical training. If there be any objection to the system which the Massachusetts city has inaugurated, this would be the only one. But this objection is so insignificant as to be easily overlooked, compared with the benefits likely to result from educational departures of this kind to individuals as well as to the country at large. There can be no more hopeful sign of the continued industrial supremacy of our country than the present interest and activity in behalf of the educational requirements incidental no less to material progress than to ethical.



Figs. 8, 9 and 10. Finding the Neutral Axis and the Stress on the Bolts for Different Conditions.

SUB-PRESS WORK AT THE SLOAN & CHACE SHOPS.

The sub-press die is an old device dating back at least one and possibly two generations, and having its origin in watch and clock factories where its ability to perform blanking operations of the most delicate nature was early recognized and fully appreciated. That this tool, though familiar in the field just mentioned, has yet capabilities in other directions which have not hitherto been fully recognized, is the impression that must be strongly borne upon an appreciative mechanic who is acquainted with the work being done in the shops of the Sloan & Chace Manufacturing Co. of Newark, N. J. This firm has for many years built precision machinery for watch makers, fine tool makers and others, whose work requires great accuracy. It was over thirty years ago that they brought out their first line of bench lathes; their line now comprises, besides the lathes and the numerous attachments used on them, automatic pinion cutters, automatic gear cutters, drilling and tapping machines, bench milling machines, and many other tools of a more highly specialized nature, especially used in watch and clock making. Small sub-press dies had been built more or less from the beginning, but within the past few years this part of the business has been developed until it equals in importance the building of machinery.

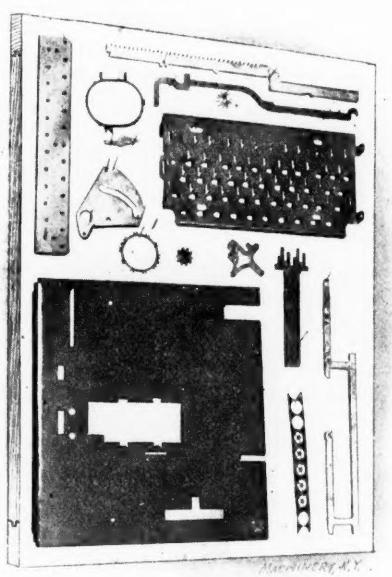


Fig. 1. Examples of Sub-press Work.

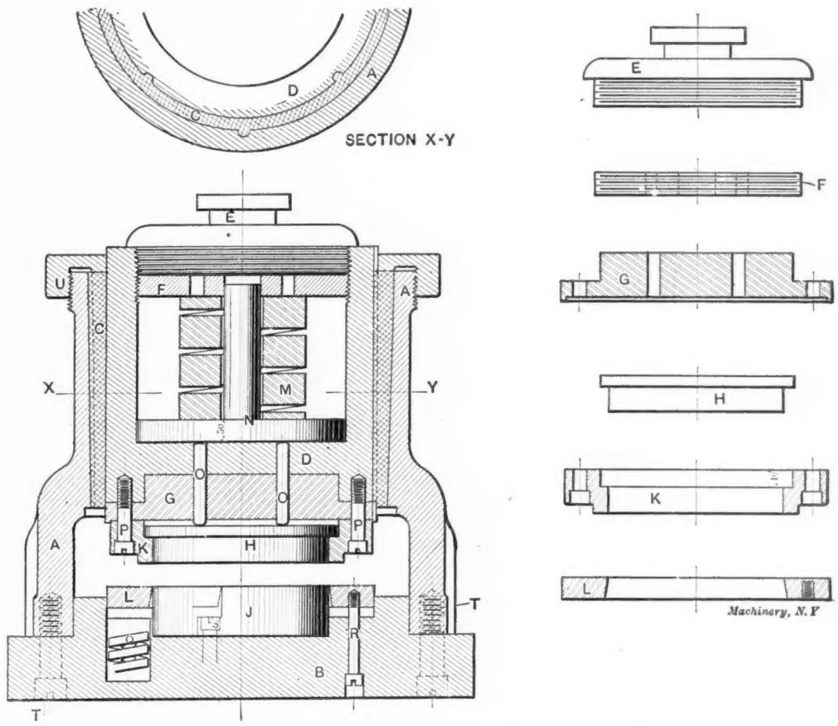


Fig. 2. Construction of Typical Sub-press.

A section of a typical blanking sub-press of the common cylindrical type is shown in Fig. 2. It is doubtless familiar to most toolmakers, so will need but a few words of description. To base *B* is screwed and dowelled the cylinder *A* lined with babbitt, as shown at *C*, this lining being provided with ribs which engage corresponding grooves in plunger *D* which works up and down within the babbitt lining under the action of the ram of the press in which it is used. Nut *U* furnishes an adjustment for tightening the babbitt lining to take up all slack due to wear, as fast as it is developed. The die is usually the upper member, while the punch is placed in the base. *K* is the die, screwed and dowelled to plunger *D;* accurately fitting the opening in this die is the shedder *H*, which is normally forced downward with its face flush with the face of the die by the action of spring *M*, which acts through the piston *N* and pins *O*. A similar construction is used in the bottom member. *J* is the punch, screwed and dowelled to the base. *L* is the stripper, surrounding the punch and accurately fitting it, and held firmly at the upper extremity of its movement by the pressure of the springs *Q*; it is restrained with its face flush with that of the punch by the heads on stripper screws *R*. Thus it will be seen that the faces of the punch with its stripper and the die with its shedder may be ground off smooth and flush with each other, presenting to the eye the appearance of two solid plates of metal, the division between the fixed and spring supported members not being visible if the fitting has been well done.

With this construction in mind, the details of the punch and die shown in Fig. 3 will be readily understood. Similar letters in each case refer to similar parts, but only the members of the device actually working on the metal are here shown. The outline of the punching which is to be made will be understood from the outline of the punch and its stripper, as shown in the plan view. There are two small holes, *c c*, and one larger hole, *b*, in the blank. For punching these small holes, in addition to the simple arrangement shown in Fig. 1, openings are necessary in the punch, and small piercing punches have to be placed within the aperture of the die, passing through holes in the shedder; the holes in the punch are continued through the base of the sub-press so that the waste material drops through beneath the machine. The piercing punches in the upper member are held to die pad *G* by holding screws *g* which draw these parts up into their tapered seats against the shoulders formed on them for the purpose. The fitting at all the cutting edges is done with great accuracy. The punch *J* fits die *K* very closely; the shedder *H* is fitted to the die very closely; the stripper *L* is fitted to the punch, and small punches *f* are accurately aligned and closely sized to their corresponding openings in the face of main punch *J*. Disappearing pins are shown at *h h;* they are used to guide the strip of stock, and are pressed down by the descent of die *K*, returning under the action of their springs as the ram ascends.

It will be understood of course that the sub-press is a complete unit, with punch and die and ram guiding surface always in place, so that no setting is necessary. The workman only needs to place the sub-press on the bed of the punch-press, insert the button on cap *E* in the holder provided for it in the face of the ram of the machine, and strap the base of the tool to the bed of the machine. He is then ready to commence work at once without any need for wasting time in matching up his dies, it only being necessary to adjust the length of the stroke to the proper amount. This is one of the advantages of the sub-press. Another of them will be immediately recognized upon considering the action of the parts on the strip metal from which the blank is punched. With the work in place, die *K* and with it small punches *f* descend, the latter passing through the stock until they almost meet the corresponding cutting edges in the lower member. As soon

as shedder H strikes the stock its motion is arrested, and it remains behind until the blank is separated, being meanwhile powerfully pressed upon the work by spring M. As the stock, while being sheared, is pressed down around the blank, it carries with it stripper L which also, by the influence of springs Q, exerts a heavy pressure on the stock. The whole area of metal being thus firmly held between plane surfaces, there is no danger of buckling or distortion of the stock as would otherwise be likely. As the ram moves upward again the blank is still firmly held on the stationary top of punch J by the shedder H. The stock, however, is carried upward

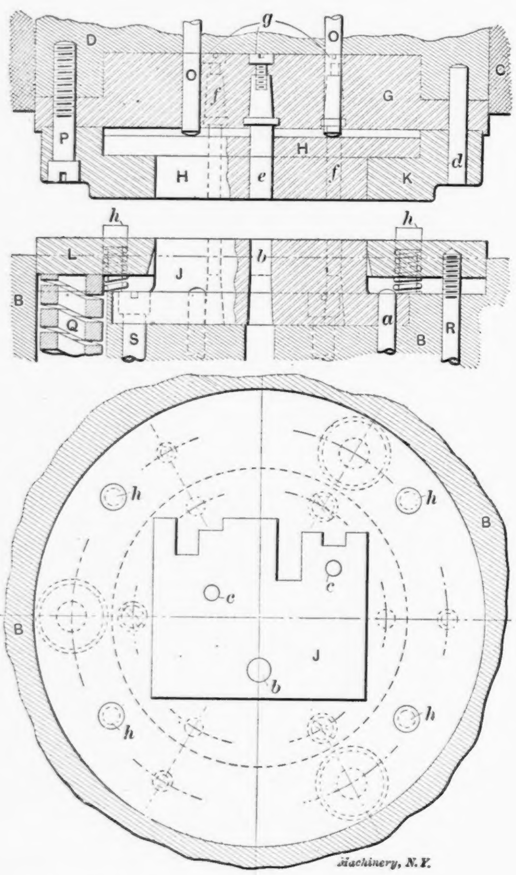


Fig. 3. Construction of Sub-press Punch and Die.

with die K by stripper L, forcing the stock back over the punching again until the movement of the stripper is arrested by the heads of screws R, at the time when the face of the stock is flush with the top of the punching. The work is thus pushed back into the stock in the same position that it occupied before it was severed from it and in many materials when the work has been nicely done, it is difficult at a careless glance to believe that anything has been done at all, both sides presenting a flush smooth surface where the parting occurred.

This condition is taken advantage of oftentimes in clock manufacturing. Gear blanks, for instance, are punched out from strips of metal and inserted back in their places again, minus, of course, the stock which has been punched out to form the arms and the hole for the "staff" or little shaft on which it is mounted. These strips, thus prepared, are then taken to machines where the staffs are inserted and fastened, it being much easier to handle the little wheels in this way than if they were severed and handled in bulk. A strip of stock thus treated is shown in the photograph reproduced in Fig. 1, the second one from the right at the bottom of the group; five of the pieces are shown in place in the stock while three have been pushed out. Besides the advantages of permanent setting of the punch and die and the holding of the stock to prevent distortion, which allows very narrow bridges of material to be left between wide openings, the suitability of the device for delicate work such as the piercing of small holes in thick stock will be appreciated by reference to Fig. 3. It will be noted that, no matter how small punches e and f may be, no portion of their projecting ends is at any time left unsupported laterally by shedder H or by the work. The shedder, pressing down firmly on the work, supports the end of the punch at the point where the pressure is applied. It is thus possible to use a very much more slender punch for a given thickness of stock than can be used in any other way. In Fig. 1, where a number of samples of sub-press work are shown, the topmost piece with the rack teeth in it, which is about 0.050 inch thick, has at its left hand end four 0.025 inch holes pierced through it. It will be seen that the thickness of the stock in this case is twice the diameter of the hole punched. Such a ratio has perhaps been undertaken with ordinary punches and dies, although the writer does not remember ever having seen the ratio of 1.5 to 1 exceeded; and in that case the hole in the die was considerably larger than the hole in the punch with the result that the pierced hole was very much tapered, the scrap coming out in the form of a conical plug. In the die under discussion, however, no allowance of this kind is made, the hole in the die being a very close fit to the punch, with the result that the hole pierced in the blank is as nearly a perfect one as could easily be obtained by any means short of reaming or grinding.

Another advantage of the sub-press, dependent in part on the accuracy of alignment provided, and the corresponding accuracy in fitting which can be given to the cutting edges, is that the work is remarkably free from fins and burrs. A consideration of the action of the press will show that there is practically no chance for burrs to form in a piece even where they would in an ordinary blanking die. It is of course necessary for the die to descend until the punch has all but entered it, if clean work is to be produced. There appears to be a slight difference in the practice of different operators in this respect, although this difference in practice would be expressed in the dimensions of only 0.002 or 0.003 inch, perhaps. Some of them adjust the stroke so that the die does not quite meet the punch. Others prefer to have them meet and even enter by an infinitesimal amount.

Attention has already been called to two of the samples of work shown in Fig. 1. The small parts there illustrated are within the ordinary range of the sub-press as used in this shop, but it is safe to say that there are many die-makers who consider themselves familiar with this tool who have yet to see dies built on this principle large enough to blank out such a piece as the largest one shown, which is quite 14 inches square. Nor is this the limit possible. The writer saw here dies of this type being made for heavy armature work, blanking out armature segments measuring possibly as high as 26 or 28 inches across extreme dimensions. The same advantages that obtain in the smaller presses, result from the use of the larger ones. There is a saving of time in setting up the tools; there is a possibility of punching small holes in

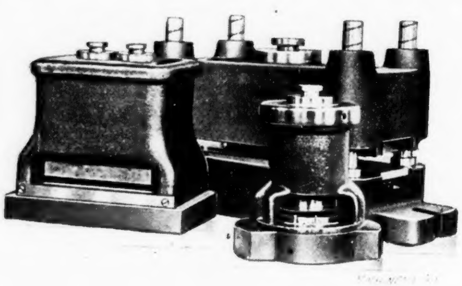


Fig. 4. Three Forms of Sub-presses.

thick stock or of leaving narrow bridges of metal between openings of considerable area; the dies, owing to their accurate and permanent alignment, may be fitted to each other much more closely, produce work that requires less finishing and comes more nearly to dimensions than can be done in any other way. At the same time, the construction effects a great increase in the life of the die, making it unnecessary to grind it anywhere nearly so often as would otherwise be the case. The only disadvantage that can be set off against these advantages is the increased cost, and it appears to be conceded that even with this consideration the balance is strongly in favor of the sub-press die.

Of course the larger sizes of these tools are not made in the familiar circular form illustrated in Fig. 2. Fig. 4 shows three different styles. The one at the rear has the sliding head guided by four vertical posts carefully ground and lapped to fit cast iron bushings. This is the construction used on heavy work. At the left is shown one in which the plunger is rectangular in shape. This works in a bearing lined with babbitt the same as the cylindrical form shown at the right of the cut and outlined in Fig. 2, although the bearing is not adjustable. The cylindrical form is used for the smaller sizes.

The making of a sub-press die requires all the skill of a and such holes as may be called for in the blank are transferred to die pad *G*. This is done by punches with outside diameters ground to fit the holes in the templet, and provided with sharp points concentric with the outside. The pad after being thus prick-punched, is put on the faceplate, the slight punch marks are carefully indicated, and holes are carefully bored to a taper to fit the punches which are to be inserted in them. The punches are finished by grinding on centers after they are hardened. They are supported at the shank by a male center, while the opposite end is temporarily ground to a point which revolves in a female center in the

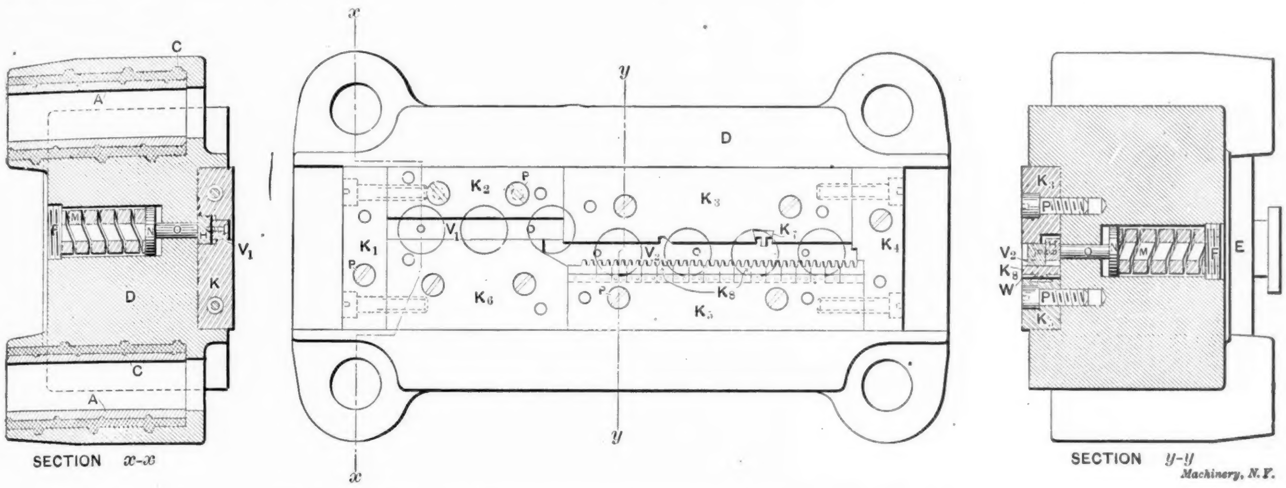


Fig. 5 Plan View and Section of Upper Member or Die of Sub-press shown in Fig. 7.

first class toolmaker. The method pursued by some, at least, of the men who are engaged in this work at the factory mentioned is about as follows: Taking the die shown in Fig. 3 as an example, the base *B* and cylinder *A* are machined and fitted together according to methods that would naturally be pursued by any good mechanic. The inner surface of the cylinder is grooved so that babbitt may be securely locked in place. Plunger *D* is then machined, and the outer surface ground and fluted with semi-circular grooves. Especial pains are taken to have these grooves parallel with the axis of the plunger in both planes; if this is not done the die may be given a slight twisting movement instead of the perfectly straight forward one that is required, since upon these grooves

other end of the grinder. The punch may thus be ground all over with the assurance that the pointed end is true with the exterior—a necessary provision as will appear later.

It might be noted here that no draft is given to any of the cutting edges of these tools, since they do not enter each other, at least not to any appreciable extent, and since the stock in entering and leaving the cutting edges is positively moved, no clearance is necessary and the die cuts practically the same kind of a blank at the end of its life that it did at its birth. Shedder *H* is fitted to die *K* and the holes for the punches are transferred to it in the same way as for the die pad, by means of carefully machined prick punches which fit the holes in the models, these prick punch marks being afterward indicated

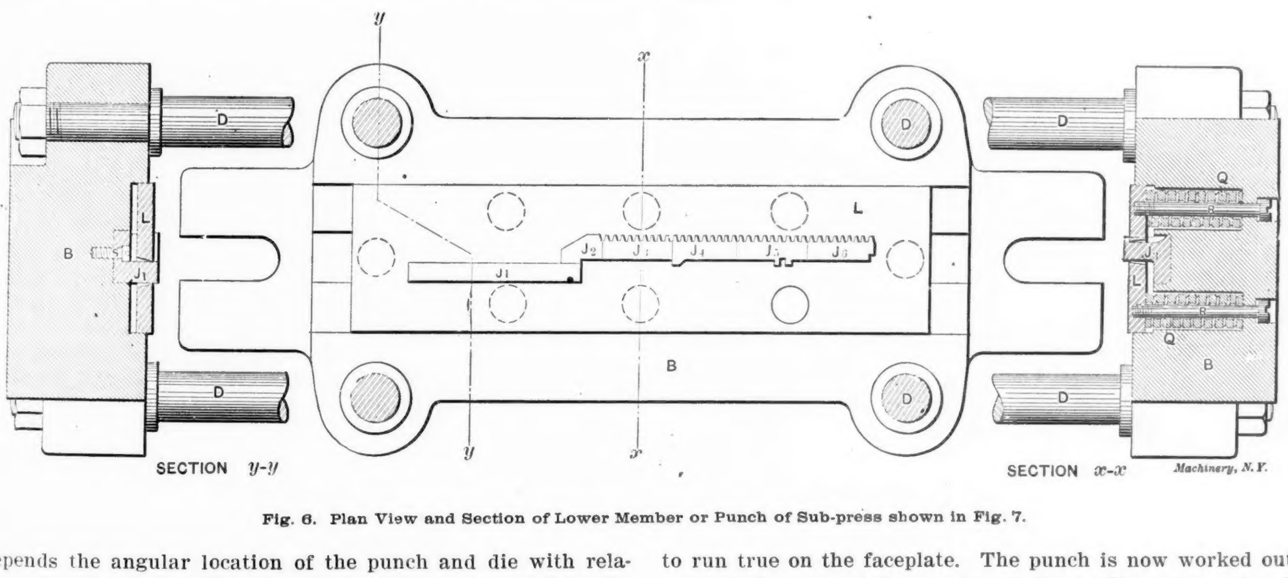


Fig. 6. Plan View and Section of Lower Member or Punch of Sub-press shown in Fig. 7.

depends the angular location of the punch and die with relation to each other. The plunger is now inserted within the cylinder and, with proper precaution, the space between them is filled with babbitt which flows into the grooves in the cylinder and those in the plunger as well, locking with one and guiding the other. After being cooled, the plunger is pumped up and down to insure a perfect bearing and the nut *U* is screwed down until all slack is taken up. Die *K* is now made to accurately fit the templet or model furnished the toolmaker as a sample. After it has been completed, it is hardened and fastened in place. Then the model is inserted within it, to run true on the faceplate. The punch is now worked out a very slight amount larger in all its outlines than the die. The model is laid upon it, the holes transferred to it as in the case of the other parts, these holes being then indicated and bored out, but not ground in this case, being left three or four thousandths smaller in diameter than finished size. The punch is fastened in place in the base, lining up as nearly as possible with the die. The ram is forced downward in a screw press until the punch enters the die very slightly, cutting a thin chip from its sides to bring them to the shape required. The punch is then worked down to this point all

around and again entered in the die a short distance further, the operation being repeated until the two parts fit perfectly.

In finishing the holes in the punch, after the hardening process plugs are driven in each of them as shown in Fig. 8. The punches *f* still with their ends pointed concentric with their outside surfaces, are fastened in position in the upper member, and the ram is brought down until these punches mark slight centers in the top of the brass plugs, when the ram is again raised and the punch *J* removed. The punch is then strapped to the faceplate and each of the small plugs is

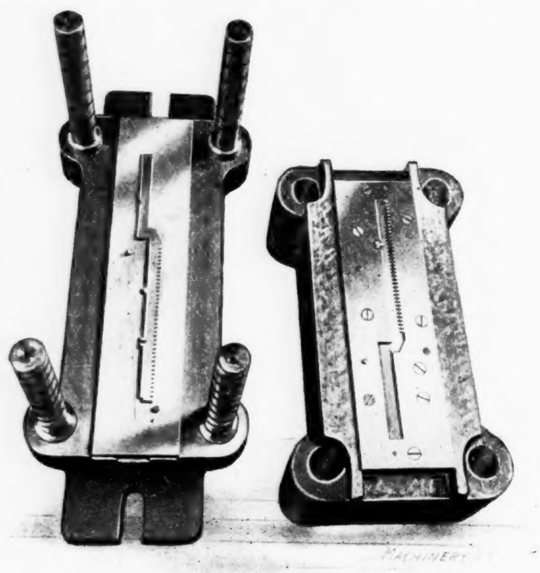


Fig. 7. A Good Example of Sub-press Construction.

in turn indicated from the prick punch marks, when it is removed and the hole is ground to size with a steel lap charged with diamond dust in an internal grinding fixture. The stripper is fitted to the punch in the usual manner. With the parts thus made and fitted great accuracy is obtainable.

A die of the four-posted type is detailed in Figs. 5 and 6, Fig. 6 showing the lower member or punch while Fig. 5 shows the upper member or die. This sub-press is used in making the piece with rack teeth shown in the upper right-hand corner of Fig. 1. A slightly different method of procedure is followed in this case than with the sub-press just described. The punch and die are finished before the upper and lower members are lined up with each other. When the time comes for doing this the punch is entered in the die, the two parts being parallel with each other as to their faces, when bushings *A* are slipped over the posts until they rest in the bottom of the cast counterbores in die holder *D*, Fig. 5. This counterbored space has had packets gouged out in the sides for

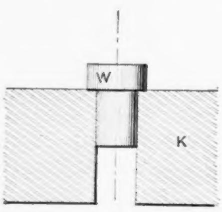


Fig. 8. Plug for Centering Holes for Grinding.

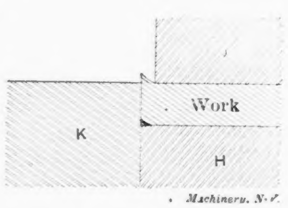


Fig. 9. Action of Badly-fitting Punch and Die.

the babbitt to flow into and lock with. The grooves shown in the posts in Fig. 4, are not yet cut in Fig. 6, they being still smooth and true as the grinding left them. The space *C* being poured full of babbitt and allowed to cool, the punch and die are permanently aligned with each other without possibility of shifting. The posts are then removed and the spiral grooves for oil distribution are cut in them.

One of the noticeable points about this die, as shown in Fig. 6, although the work is so closely fitted in the tool itself that the eye is scarcely able to distinguish the construction, is the fact that the section of the cutting edge which shears out the rack teeth is built up of small segments, each containing two teeth only, these segments being dovetailed into the larger piece, K_5. Each of these small pieces, K_8, is secured by two dowels which pass through from side to side of K_5, locking the parts firmly together. This costly and difficult construction was necessitated by the demand for accuracy in the spacing of the teeth. With the sectional construction shown the parts are not affected sensibly in the hardening. That piece K_5 may not be warped out of shape; it is ground to size in all its surfaces, top, bottom, sides and even in the dove-tail, so that when completed its plane surfaces are straight and parallel. The dove-tails of the die sections K_8 are next machined to fit this and inserted, being then spaced the proper distance apart. The holes in K_5 are then continued through pieces K_8, which are taken out and hardened, and returned to be dowelled in place. It will be seen that this die is constructed on the sectional plan throughout. This makes it possible to finish on the surface grinder most of the cutting edges. Troubles due to distortion in hardening are thus entirely avoided. The proper end measurements between vital points in the model are also preserved by leaving a slight amount of stock where two sections of the die come together, the parts being ground away at this point until the proper dimensions are obtained.

In the few cases where the grinding wheel will not finish the cutting surface, great use is made of diamond laps, these being in the form of steel sections of proper contour to fit the part of the die they are working in, these steel pieces being charged with diamond dust and reciprocated vertically

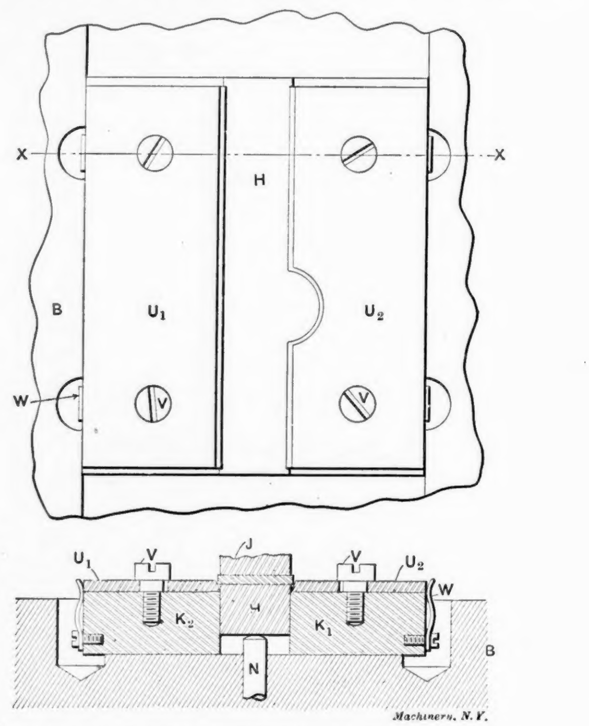


Fig. 10. Shaving Die with "Nest" for Locating the Work.

in filing machines, of which a large number are used in this shop. The little dove-tail in which part K_7 is inserted, for instance, was finished in this way. The back of the dove-tail is perpendicular but the two sides slope somewhat from the vertical forming a wedge-shaped opening enlarged toward the rear. Section K_7 is then driven in from the rear, finished off, and ground with its front face flush with the rest of the die. In Fig. 7, which shows this sub-press, this little section has not yet been finished off, so that it is seen to project above the remaining part of the die.

This is the first operation or the blanking punch and die. The pieces produced are afterward subjected to the action of a shaving die, the original blanks being left with 0.002 or 0.003 stock for this purpose which is trimmed off in the final operation. The punch for this first or blanking die has the rack section subdivided into four parts only, which are matched up carefully with the sectional die just described. In the shaving die, however, this punch is built in sectional form as described above for the blanking die, so that great refinement in measurements is secured.

The sub-press just described is that shown at the back of Fig. 4 and opened up in Fig. 7. Its action is exactly identical with the smaller one just described; it has all its advantages and presents the same deceptive appearance of perfectly homogeneous surfaces in the punch and die when it is completed. In the illustration the shedder and stripper springs have been slacked up in order to show the outlines of the cutting edges, but this is not the normal condition.

A feature of the shaving die system, to which reference has been made, is the use of a "nest" to locate the work. In this trimming operation the punch is in the upper member and the die in the lower one. On the surface of the die, of which an example is shown in Fig. 10, are placed steel guiding plates, U_1 and U_2, which form the nest referred to. They have their edges shaped to the outline of the piece to be operated upon and they are pressed inward by flat springs *W* at the outer edge, being allowed a slight lateral movement although retained from sidewise displacement by shoulder screws *V*. The holes through which these screws pass are slotted to permit this; the end of the slot limits the inward movement of the plate. As shown in the enlarged views, Figs.

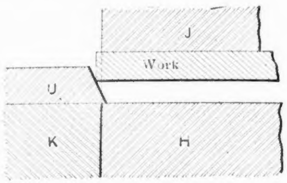


Fig. 11. "Nest" with Work in Place.

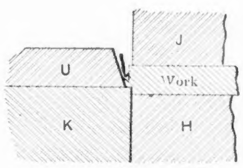


Fig. 12. Work being Trimmed in Shaving Die.

11 and 12, the inner edges of these plates are bevelled backward so as to form a recess in which the work may be located. The descent of the punch forces the plates out, which, as they are displaced, still guide the work so that it is properly centered over the die. These beveled edges of the plates have the further advantage of curling the chip out of the way where it does not clog the tool and may be easily cleaned off. The shedder coming up from below and removing the work, closes the lower opening effectively so that the whole device is chip tight.

Even greater accuracy is advisable in the fitting of the punch and die in this shaving sub-press than is necessary in that used for blanking only, if it is desired to produce clean work free from burrs. The necessity for this will be appreciated upon examining Fig. 9, which shows in magnified form the action of the cutting edges. If the punch *J* does not match up closely with the edge of die *K*, the stock is bent upward leaving a sharp burr, while the punch impresses the outline of its cutting edge on the top surface of the blank.

Mr. Haney, the general manager of the Sloan & Chace Mfg. Co., has ambitions for this branch of the firm's product which are by no means modest. It is his aim to build the greater part of the dies made in this country for purely manufacturing purposes. The idea of having the tool work of a manufacturing firm done by an outside party has a number of commendable features about it. Suppose a new concern is about to enter in business as a manufacturer of typewriters. There has to be an enormous initial expense for tools and, as a part of it, the buying of a great many costly machines, the establishment of a large toolmaking department, together with the hiring and organization of an efficient toolmaking force—an exceedingly difficult undertaking. In general it entails an amount of worry and expense which can only be appreciated by those who have been unfortunate enough to have actually met these conditions. Where it is not necessary to have a larger toolroom equipment and organization than is required for keeping tools in repair and for making occasional additions to the line as slight changes are made, a large part of the time, expense, and worry might be avoided. This is where the independent toolmaking firm has its strong hold. Filling orders for a great number of different concerns, they can have a nearly constant volume of business, a constantly used equipment of fine machinery, and an efficient corps of diemakers, working under the assurance that their jobs are permanent ones; this would not be the case were they working for a new firm just starting in business, who then require many more men in making these tools than they will to keep them in repair and make occasional changes.

It is evident that manufacturers have begun to look at the matter in this light, for the firm of which we are speaking has more of this work on hand at the present time than it can attend to, some of their contracts being of a size that is startling both as to the number of tools and their money value. The only factor which hinders a rapid growth of this business to many times its present size is the fact that it has so far been exceedingly difficult to get men who are capable of doing the work that is required of them. Almost all of the workmen have learned the business in this shop, some of them having been there for many years. Of the many who have come in response to advertisements and in the ordinary course of their wanderings, only a few have been found who are able to meet the demands made upon them. The firm is preparing in the near future to institute an apprenticeship system with the hope of educating bright boys to be capable and efficient diemakers.

* * *

STRAIGHTENING RACKS MADE FROM COLD ROLLED STEEL.

The phenomenon of skin tension in cold rolled steel is one with which all shop men are familiar. This process of working the steel develops permanent stresses in the outer portion of the metal, and if this outer portion is taken off on one side of a square bar, for instance, the stresses in the opposite and untouched side will be sufficient to draw the stock into an arc of a circle. This condition is met with in cutting racks in square cold-rolled stock, a practice in common use at the present time, since it avoids the necessity for planing the four sides of the work as would have to be done if machinery steel were used. After the teeth are cut in these racks, they are so distorted that drastic treatment has to be applied to bring them back to a condition in which they are fit for use.

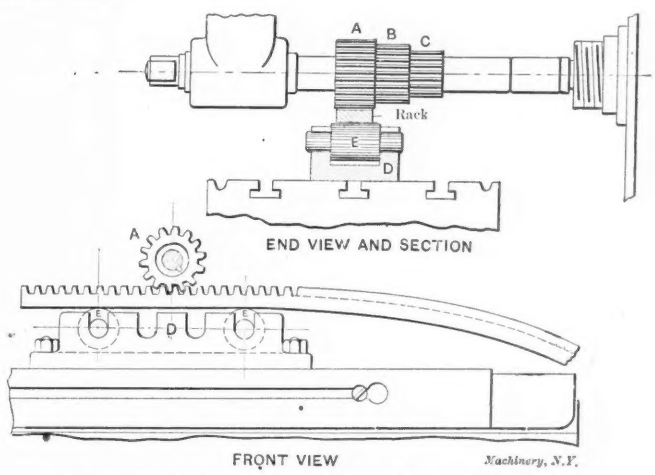


Fig. 1. Straightening Cold-rolled Racks in the Milling Machine.

Fig. 1 shows the principle of a device for this purpose which has been used for some time by the R. K. Le Blond Machine Tool Co., Cincinnati, Ohio.

A plain miller, which stands near the rack cutter, is made use of. An arbor is mounted in the spindle, carrying, ordinarily, three gears, *A*, *B*, *C*, of the pitches most commonly used. On the table is clamped a channel casting *D*, which is provided with four slots in each side, in which may be placed the rollers *E*, which are made of about the dimensions shown. The use of the device will be readily apparent. The rolls are dropped into place at such a distance apart as best suits the work in hand, and are brought in line with the proper gear on the arbor, which is then located centrally between the two rollers. The rack is now fed in between the rollers and the gear, and the table is brought up until pressure enough is exerted on the rack to straighten it. The spindle is revolved slowly and the rack feeds through and is bent back into shape again by the pressure between the rolls and the pinion. The gears *A*, *B* and *C* are so proportioned that they bear on the tops of their teeth as well as on their sides. This prevents stretching the racks when in mesh with the gears. Were this

not so, the wedging action of the gear teeth, under heavy pressure, would spread the rack teeth and increase the pitch, lengthening the rack to some degree at least.

While this arrangement worked well on small racks, when it came to the heavier ones the straightening imposed a strain of several tons on the spindle, and it took about 3 horsepower to drive the work through the rolls. This was too severe service to give the miller, and a special machine was therefore designed, working on the same principle but better adapted for its intended use. The machine consists essentially of a bed *A* (mounted on suitable legs of ordinary pattern) to which is cast the bracket *B* carrying the main spindle *C* of the machine; the bracket in its design resembles the column of a Stiles pattern punch press. At *D* is a block adjustable for the desired height through hand wheel *E* and the attached gear train *F G* and elevating screws *H*. These elevating screws run in nuts seated in counterbores in the bed of the machine. Pulleys *J J*, driven in opposite directions by open and crossed belts at suitable speed for the work being done, run loosely on shaft *K*; either of them, however, may be clutched to the shaft by moving handle *L* to the right

ENDURANCE RECORD OF TAPS.

In a comment on the endurance record for taps which appeared in the November issue, Samuel Hall's Sons, New York, say that they have an average of a ¾-inch tap tapping 10,400 nuts ¾-inch thick; and a 1-inch tap tapping 9,300 nuts 1-inch thick.

William H. Haskell Mfg. Co., Pawtucket, R. I., say: "We do not think that the number of holes tapped as mentioned by your correspondent is exceptional, as we should consider, that unless a tap of the size mentioned tapped a considerably larger number of holes than is mentioned by you, that the tap was faulty. We know that our taps tap more than 10,000 holes, but how many more, we cannot tell."

The Boston Bolt Co., Boston, Mass., say they would not consider that these taps did any specially large amount of work inasmuch as 10,000 holes in cast iron is not much work for a tap to do. Their explanation is that under favorable conditions a tap should tap at least 25,000 nuts of wrought iron, and they imply that the same tap should be good for a greater number of holes in cast iron than in wrought iron.

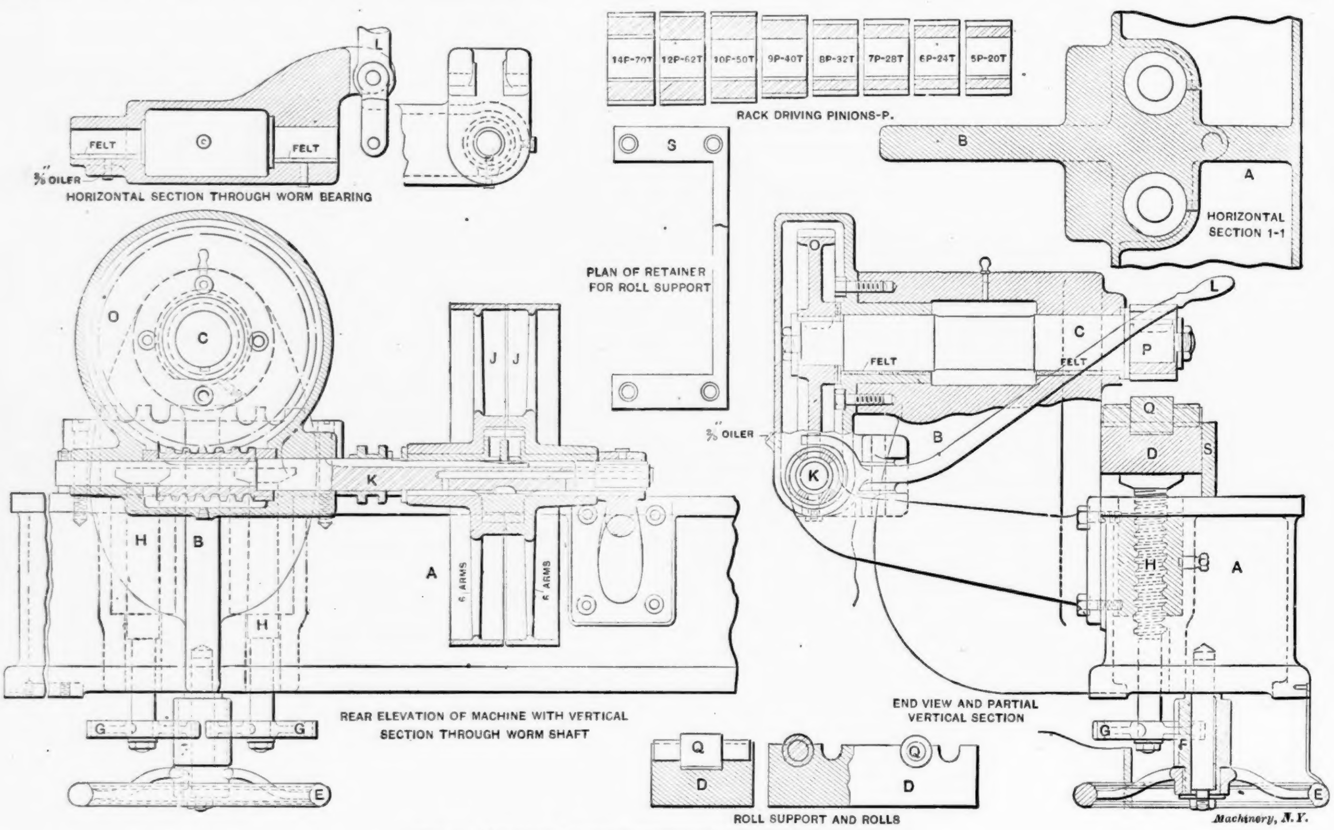


Fig. 2. Machine for Straightening Cold-rolled Steel Racks.

or left, as may be desired. This handle operates an internal clutch similar in construction to the well-known device used on the double back gears of the Le Blond milling machine. To shaft *K* is keyed a worm, which in turn drives worm wheel *O* and through it spindle *C*. On the end of the spindle may be mounted any one of the gears *P*, which are made in pitches ranging from 5 to 14 to agree with the rack which is to be straightened. Rollers *Q*, which furnish a support for the rack, revolve in seats in block *D* in a manner exactly similar to the device illustrated in Fig. 1. As in the previous case four different slots are provided so that the distance between the rolls may be varied to suit the stiffness of the rack being straightened. The operator stands at the right of the machine in Fig. 2 with his hand on the controlling lever *L* and runs the rack back and forth, bringing up the rolls meanwhile with the handwheel *E* until the rack has been straightened. The handwheel is graduated in thousandths of an inch to allow the wheel to be brought to the same point each time when running through a lot of similar racks. The details of this device, which are very well worked out, can easily be gathered from a study of the drawings, which are shown in Fig. 2 complete in every respect save that the dimensions are omitted.

"The number of holes we could tap probably depends upon the quality of the stock, on the temper of the tap, and also how much stock the tap has to remove. We should not be surprised if under some conditions a 1-inch tap would tap 40,000 nuts. We have no exact data to which we can refer but certainly if a tap did not tap 10,000 pieces we would consider it inferior."

The Garland Nut & Rivet Co., Pittsburg, Pa., say that in tapping iron and steel nuts they could not approach the record made by Mr. Sallow's taps.

The Graham Nut Co., Pittsburg, Pa., say the tapping of nuts is largely regulated by the speed of the tap and consequently the tap sometimes suffers on that account. They consider about 5,000 inches a good average for nut taps. This would be equal to about two-thirds the record made by Mr. Sallow's taps.

* * *

The excellence of the design of the sister ships *Lusitania* and *Mauretania* of the Cunard Steamship Co. is made publicly evident from the fact that the company has been awarded a grand prize for these models at the Milan Exposition. The prize awarded extended also to other models of the company's well-known steamers.

ADJUSTABLE FORMER FOR BEVEL GEAR PLANING.

G. L. H.

It is a well-known fact that in order to correctly plane the teeth of a bevel gear the cutting point of the tool should work toward the apex of the pitch cone. Bevel gear planers are built on this principle, the tool rest slide being hinged at one end in the apex of the pitch cone of the gear being cut (or at least arranged so that the tool will travel toward that point), the other end being supported on a former which determines the shape of the tooth. This principle is illustrated in Fig. 1. A convenient method of cutting ordinary bevel gears by the use of a comparatively small number of formers is described in the following paragraphs.

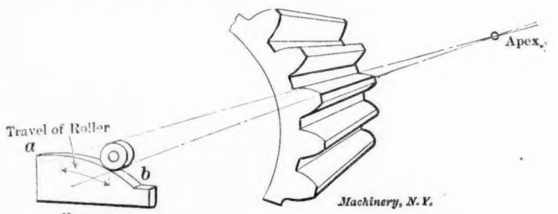


Fig. 1. The Principle of the Bevel Gear Planer.

Bearing in mind the fact that to a given circle there corresponds one and only one shape of involute, one can readily see by referring to Fig. 2 that a pair of formers, one for the upper and one for the lower side of the tooth, would serve for all gears if they could be set at any desired distance, H, from the apex of the pitch cone. If the shape of the former is the same as that of a gear tooth whose pitch radius is R, it will be suitable for cutting the bevel gear indicated by a full section, as the curvature of the gear tooth will be reduced from the curvature of the former in the same proportion as R is to r; but a bevel gear of any other pitch cone angle and number of teeth, for instance the one shown in part only, having a pitch cone angle A_1, can be cut with the same former, if only this former be set in the new pitch cone at such a distance, H_1, from the apex that the new pitch radius, R, is the same that it was before. The number of teeth in either of the gears is immaterial so long as the templet is long enough. A long tooth will use the whole of the templet from a to b, as shown in Fig. 1, while a shorter tooth, such as that represented as being cut, will only use as much of the former as is indicated.

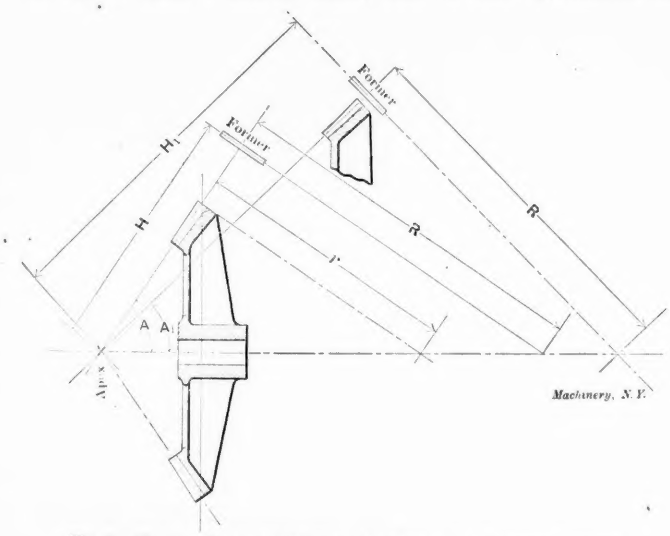


Fig. 2. Planing Gears of Different Angles with the same Former.

As stated, it would be possible for one former to cover the whole range of pitch cone angles A, but since on any given machine, distance H has but a limited variation, this necessitates a series of formers in order to include all the gears capable of being cut on the machine. Suppose we have a machine on which a former can be set between 30 and 45 inches from the apex. Let H and H_1 in Fig. 2 represent these two extremes of distance, respectively. It is apparent from this diagram that $\frac{R}{H} = \tan A$. If 2 inches is the smallest value for R to be used on this machine we can, by using it in the above formula with different values of H between 30 and 45, obtain the corresponding values of A which, when laid out on the diagram, Fig. 4, will be represented by the curve $c\,d$. This diagram has, however, been extended, giving a minimum value to H of 20 inches and a maximum value of 55 inches. In a similar way all the other curves are found, the values of R for each succeeding one being chosen so that each curve intersects the 45-inch line at about the same value for the pitch angle that the preceding curve intersects the 30-inch line, thus always covering the field between 30 inches and 45 inches, the assumed limits of the machine.

Take, for example, a bevel gear with a pitch angle of 30 degrees; according to the diagram the 21-inch former, or a former made for a radius, $R = 21$ inches, is the one to be used, and the reading of the diagram shows that it should be set about 36¼ inches from the apex. If the machine allows a shorter or longer adjustment of the former than that assumed above, the 31½-inch former at about 54 inches or the 14-inch former at 24¼ inches from the apex would give the same tooth form. When the pitch radius of the former exceeds 200 inches the involute for any ordinary pitch of tooth is practically a straight line, and a former laid out accordingly may be set at any distance from the apex.

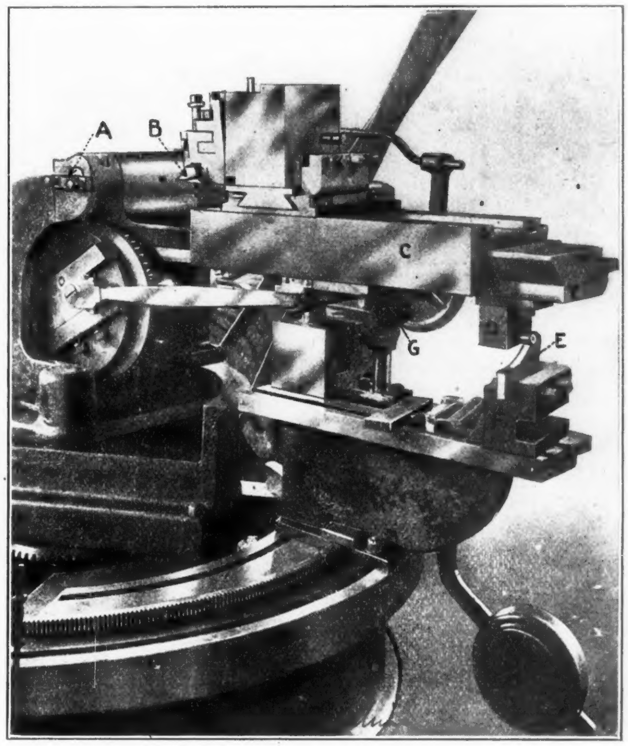


Fig. 3. Gear Planer Arranged with Adjustable Former.

In the above remarks involute formers only have been considered. Owing to the fact that the cycloidal curves vary not only with the pitch radius, but with the pitch as well, and consequently with the number of teeth in the gear, a simple diagram as shown above cannot be obtained for cycloidal formers.

Fig. 3 shows a tool slide and its controlling mechanism on a Gleason gear planer. At A is the apex of the pitch cone of the gear, the point toward which the tool B always travels. C is the reciprocating slide on which the tool is mounted. At D is the block carrying the former roller which follows the outline of former E; F is the support for the former. Both F and D are readily adjustable between the limits, in this machine, of 30 and 45 inches, as explained above. Counterbalance H supports a post and short track on which runs roller G attached to the support for the cutter slide. This serves to take a large part of the weight of the mechanism off of the former, thus making the guided parts more sensitive and easily handled.

[The scheme described above by our contributor allows the use of a smaller number of formers than would otherwise be necessary and practically makes allowance for the errors that

would be introduced in cutting, in the usual way, a gear whose pitch angle was about half-way between those of the two nearest formers. So far as we know, however, the make of planer to which this idea may be applied is not built at the present time in such a way that the distance from the former to the apex is adjustable. The machine shown in Fig. 3, on which the idea worked very nicely, is evidently of an old design. In the later machines, as we understand the matter, dimension *H* in Fig. 2 is constant for any given machine, and the formers are made to fit this dimension, being cut in a generating machine by a milling cutter, on a spindle which is pivoted to swing about the apex of the pitch cone in the same way that the tool slide does.—EDITOR.]

* * *

Aluminum may within the near future enter into serious competition with copper for the transmission of electricity for lighting, traction and power purposes. While the electrical conductivity of aluminum is only 63 per cent of that of copper, the specific gravity of the metal is less than one-third of that of copper, and thus conducting wires of aluminum, although of larger sectional area than those of copper with equal conductivity, will still be less than one-half the weight of the latter. It follows, therefore, that even if the price of aluminum were double that of copper, which it is not, a bare conductor made of aluminum would still be somewhat cheaper than the copper conductor. With insulated conductors there will be some difference owing to the additional insulation material made necessary by the larger area to be covered. —*Practical Engineer.*

THE WORLD'S SUPPLY OF IRON ORE.

Some time ago a prominent Scandinavian metallurgist predicted a famine in iron ore in about 100 years' time. In the United States this famine was to occur within thirty or forty years at the present rate of consumption. This, however, was not founded on a basis of the consideration of all the facts in the case. There is in existence a great amount of iron ores at the present time not considered worth using, because of their impurities. In the future, however, if the supply of the purer iron ore now used should prove to become less abundant, it is safe to predict that these ores will be largely used to make up the world's supply. This is true no less of America than of Europe. A number of mines were closed thirty or forty years ago in England because cheaper and better iron ore cut them out of the market, but when this supply of cheaper and better ore will be exhausted, the old mines will most certainly be reopened. An English metallurgist claims that three counties in England would supply that country at the present rate of consumption with ore for 200 years, and that considering all the iron ore possible to be used, Great Britain would have enough to last for 1,000 years without importation, provided that the consumption would not rise above the present rate. Probably similar statements would be true of the United States, and it is in all likelihood too early to commence to contemplate what to do when the world's supply of iron is exhausted. Methods are constantly being perfected for cheaper ore reduction, and while the quality of ore which will be used in the future may be poorer, the price of iron itself need not necessarily rise to any great extent.

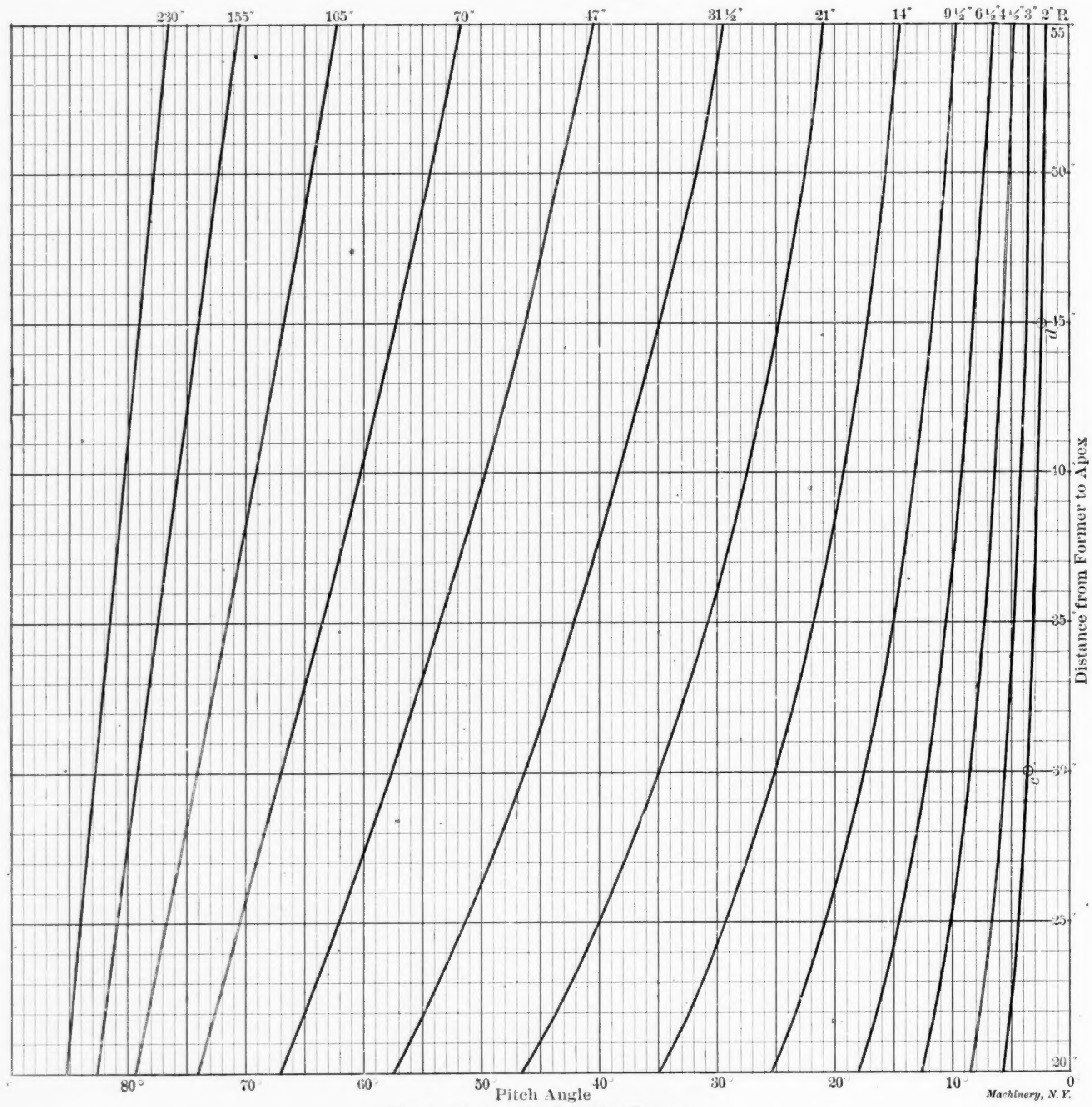
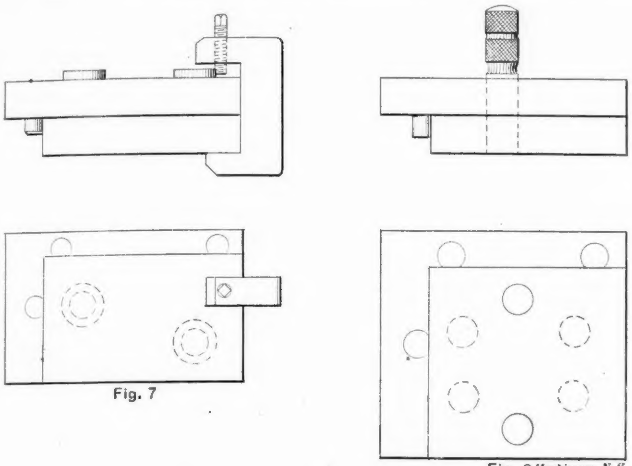


Fig. 4. Diagram for Selecting Formers.

DRILL JIGS.—2.

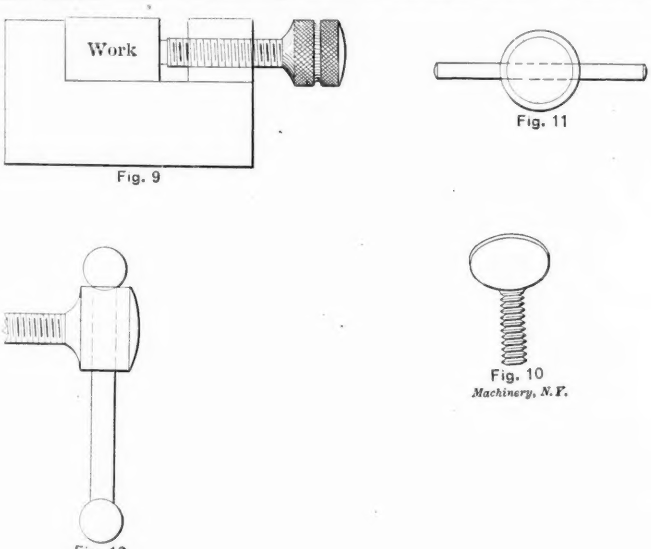
E. R. MARKHAM.

Holding Devices.—It is necessary to hold the work solidly in the jig without any chance of its changing location. Should the location change after one or more holes are drilled, and before all are drilled, it would cause a variation that would in all probability spoil the piece of work. When but a few pieces are to be drilled with a jig it is not generally considered advisable to make jigs with fastening devices, the work being held in place with a clamp, as shown in Fig. 7. In order to do away with any possibility of change of loca-



Means for Holding Work in Drill Jigs.

tion, a pin is forced through the jig hole and the hole in the work after drilling the first hole. If many holes are to be drilled in a piece it is advisable to have two pins. After drilling a hole in one end of the piece, force in a pin, then drill a hole in the opposite end, and place a pin in this hole, as shown in Fig. 8. The pins in opposite ends of the piece will prevent its slipping when the rest of the holes are drilled. Many different forms of fastening devices are provided, the design depending on the class of work. One of the most positive methods consists of a screw which passes through a stud or some elevation on the jig, and presses against the work, forcing it against the locating points, or stops, as they are called. The screw may have a knurled head, as shown



Means for Clamping Work in Drill Jigs.

in Fig. 9, or a thumbscrew may be used, Fig. 10. Sometimes it is necessary to exert greater pressure than can be applied by means of a screw of the ordinary form. Then, it is possible to make a screw with a round head, drill a hole through it, and through this hole pass a piece of wire as shown in Fig. 11. By this screw sufficient pressure can be applied. When it is necessary to exert a greater amount of power than would be possible by the use of a pin of the length shown in Fig. 11, one may be used that will slide freely in a hole in the head of the screw. A ball placed on each end prevents its falling out. By getting the full length of the pin on one side of the screwhead as shown in Fig. 12, a much greater amount of power is obtained. At times the stud which supports the screw may interfere with the placing of the work in, or the removal of the work from the jig, or it might be necessary to turn the screw for a considerable distance each time the work was placed in or taken out of the jig. In such cases a stud could be provided that could be removed from the jig when the screw was relieved of its tension against the piece of work. Such a stud is shown in Fig. 13.

The more common method of fastening work is by means of a cam of suitable form. Cams of the ordinary design are not as powerful as the screw, but they have the advantage of being more quickly operated, and in the case of light work where but little strength is required, they answer the pur-

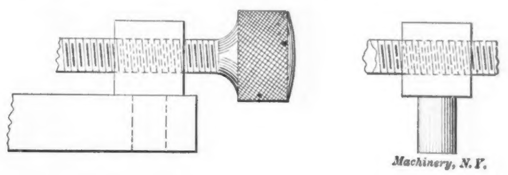
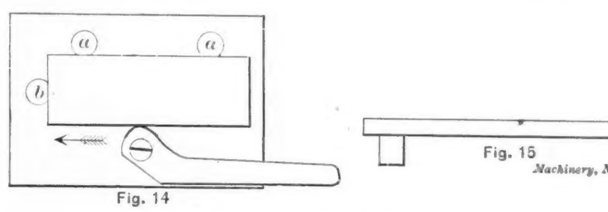


Fig. 13. Clamp Screw Mounted in Removable Stud.

pose much better. The designer should bear in mind that a few seconds' time saved on each piece of work amounts to a large saving in a day when a number of hundred pieces are placed in and taken out of a jig. And in these days of competition every means of saving time consistent with quality of work should be considered. When the work bears against two points—one on the side and one on the end—the cam should be designed so that its travel against the work will force it against both, rather than away from one. Fig. 14 shows a piece of work held by a cam which, by means of the handle, forces the work inward and in the direction of the arrow, thus holding it against the locating pins *a a* and the end stop *b*. In order to get as much pressure as possible with a cam, it is necessary to have the portion that bears against the work when it is against the locating surfaces nearly concentric with the screw hole. This being the case, it is obvious that the pieces must be very nearly of one size, while in the case of a screw binder any amount of variation may be taken care of. Thus it will be seen that a screw may be used where a cam would not answer. However, it is advisable to use a cam in preference to a screw when possible, but at times the piece of work may be subjected to repeated jars which would tend to turn a cam, thus loosening the work. In such cases a screw is preferable. If a cam would be in the way when putting in or taking out work, it may be made removable as



Cam Clamp for Drill Jigs.

shown in Fig. 15. At times a tapered piece of steel in the form of a wedge may be used to hold work, as shown in Fig. 16.

When many pieces are to be drilled in a jig made in the simple form shown in Fig. 17, the drill wears the walls of the holes, enlarging them sufficiently to render accuracy out of the question. Where jigs are to be used enough to cause this condition, the stock around the walls of the hole may be hardened, if the jig is made from a steel that will harden. If made from machinery steel, the stock may be casehardened sufficiently to drill a large number of pieces without the walls wearing appreciably. This, however, would not answer when accuracy is essential, as the process of hardening would have a tendency to change the location of the holes.

When the jig is to be used for permanent equipment, or

where many holes are to be drilled, it is customary to provide bushings—guides—made of tool steel and hardened. These are ground to size after hardening, and being concentric, may be replaced, when worn, by new ones of the proper size. It is the common practice to make bushings for drill jigs on the same general lines as shown in Fig. 18, the upper end being rounded to allow the drill to enter the hole readily.

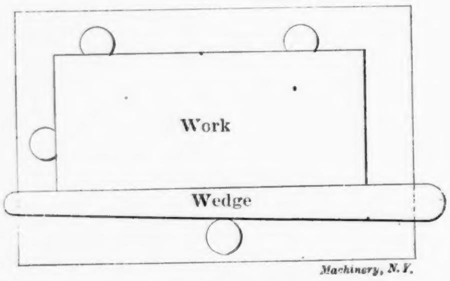


Fig. 16. Wedge Acting as Clamp in Drill Jig.

A head is provided, resting on the surface of the jig; the portion that enters the hole in the jig is straight, and is ground to a size that insures its remaining securely in place when in use.

If the hole is sufficiently large to admit a grinding wheel, it is ground to size after hardening. In such cases it is, of course, necessary, to leave the hole a trifle small—0.004 inch—until it is ground. If the hole is not large enough to allow of grinding, or if there is no means at hand for internal

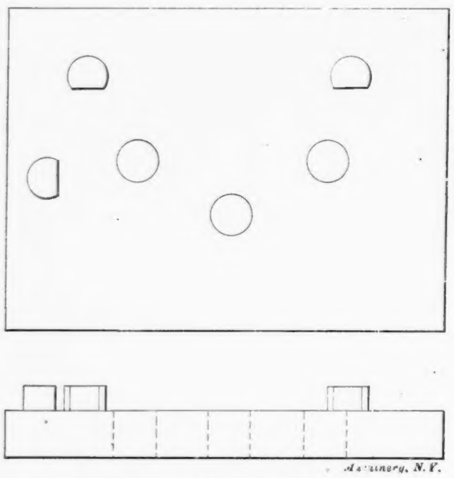


Fig. 17. Simple Form of Drill Jig without Bushings.

grinding, the hole may be lapped to size by means of a copper lap, using emery or other abrasive material, mixed with oil. When the hole is to be lapped rather than ground, leave a smaller amount of stock to be removed by the operation, say 0.001 inch or 0.0015 inch. After grinding or lapping the hole to size, place the bushing on a mandrel and grind the outside until it is a pressing fit in the hole. While on the mandrel be sure to grind the under portion of the head, *a*, Fig. 18, to insure its being true with the body. Before start-

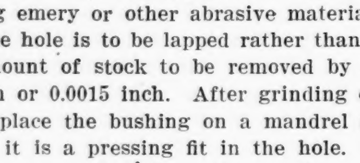


Fig. 18 Fig. 19
Machinery, N.Y.

Bushings for Drill Jigs.

ing to grind the outside of the bushing, test the mandrel for truth. This should be done *after* placing the bushing on it rather than before.

It is the custom in some shops to make the outer portion of bushings tapered, as shown in Fig. 19. Unless there is a sufficient reason for so doing, this is to be avoided, as the operation of making a tapered hole, unless it is bored on the taper with an inside turning tool, is not likely to produce a hole, the axis of which is at the desired angle to the surface of the jig. The outer portion of the bushing can easily be ground to the desired taper, but there is the liability of a particle of dust getting in the hole when placing the bushing in the jig. A tapered bushing, in order to get the proper taper, necessarily costs a great deal more than a straight one, and cannot answer the purpose any better, and probably not as well.

* * *

THE AUTOMOBILE SALESMAN AND HIS GOODS.

A. P. PRESS.

I send you a little yeast to lighten up the heavy matter; not that it is indigestible, but even a mechanic has more "wheels" than he can digest, sometimes. I am well aware that this is out of your line, and if you wish to throw it back on me, do not be afraid to do so; there will be no hard feelings.

You will remember I wrote you a year or two ago about the automobile (steam) salesman, and his expanding valve that kept the steam on the engine at any desired pressure, regardless of what the boiler might indicate, and also about his dividing line in the center of the boiler, so that if one-half burned out, you had the other half to come home on. I came across him again the other day; he was seated in a good-looking car of a well-known make, in the midst of an admiring crowd to whom he was extolling the virtues of the "auto."

"You see, boys, it is like this. This car ain't a circumstance to some of the new ones we are putting out, and while I ain't

"Our new model for 1908 is fitted with a chuck on the end of the engine shaft with lathe and milling attachment."

allowed to say much about it, I will say this: Our new model for 1908 is fitted with a chuck on the end of the engine shaft with lathe and mill attachment, so that no matter what happens, all you have to do is to put the drill in the same and make your own repairs, wherever you may be. Oh! I forgot to tell you; there is a vise, too, on the end of the tonneau. You see it makes you absolutely independent of any garage or machine shop. Then, the hydraulic cushions are new things——"

"Pneumatic, you mean, don't you?"

"No! No! I mean hydraulic. Each cushion is made watertight and pumped up full. It makes the nicest seat you ever saw in your life. Then, it is connected with the cooling system from the radiator, so it keeps the seat cool in summer and warm in winter. I tell you what, it is great. Then, there is another one; we ain't saying much about it yet; it is for use out on the western prairies. It is fitted up with a cornshelling and bobbin-winding attachment. There is one farmer boy who has half paid for his, going around to houses and winding up bobbins at five cents per spool.

"One of the 'freaks' that we built on a special order is for a chicken fancier, who wanted to get clear of using gasoline. There is a large coop placed on the rear of the tonneau to hold about one hundred hens, and then every spoke in the wheel

is hollow. These are connected with a trap nest in the coop, so that the eggs run down through the hub and out into the spokes, just the same as that well-known 'perpetual motion' machine you have all heard about. The momentum of the eggs rolling out into the spokes keeps the thing going at a fair rate of speed."

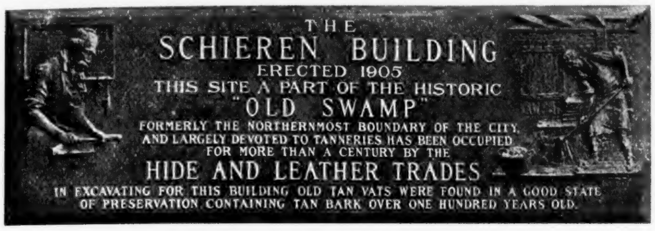
"Yes," said one of the bystanders, "but what becomes of the eggs?"

"Catches them in a basket down at the bottom, and by the time he gets to town he has enough to pay for the automobile," said the salesman, as he slipped in his high gear and chugged away.

* * *

TABLET COMMEMORATING THE LOCATION OF THE HIDE AND LEATHER TRADES IN NEW YORK CITY.

The accompanying cut shows the bronze tablet mentioned in the business items for November, which was unveiled in New York October 27 in commemoration of the location of the hide and leather trades. This part of the city, known as the "Old Swamp," has been the home of the hide and leather trades for over a century. The site chosen for the tablet is the wall of the Schieren Building at the corner of Cliff and Ferry Sts., directly east of the Post Office. In the early days this locality was the site of numerous tanneries, these being the foundation of the present hide and leather industry in New York, and the industry still clings to this part of the



Bronze Tablet in the Wall of the Schieren Building, New York.

city, although the tanneries and the malodorous swamp have long since disappeared. The bronze tablet calls attention to the former existence of the tanneries on the site, stating that in excavating for the foundation of the building old tan vats were found in a good state of preservation containing tan-bark over one hundred years old. The tablet was unveiled in the presence of several hundred men connected with the hide and leather trades of New York and vicinity, and a luncheon was afterward served in the Schieren Building. An article on the Schieren Building and the manufacture of belting as conducted in the Schieren factory, was published in the May, 1906, issue.

* * *

It has become a custom with a great number of people to make an estimate of a country's prosperity from the amount of that country's exports. The fallacy of making an estimate of the prosperity of a country on such a ground is most easily apprehended if we compare the per capita exports of some European countries with the per capita exports of our own. There is no doubt whatever but that the general prosperity of the United States far exceeds the general prosperity of any European country, still the per capita exports of Germany and France have, at least up to the end of the last fiscal year, been both larger than the per capita exports of the United States. The per capita exports of the United Kingdoms are nearly twice as large, the per capita exports of Switzerland two and a half times, of Belgium three times, and of the Netherlands seven times as large as that of the United States. This seems to indicate that the country's prosperity does not entirely depend upon the amount of foreign exports, although this may be an important factor. It depends upon the internal conditions in the country, and American manufacturers do well in recognizing, that while the foreign trade may be an important item, the greatest possibilities for the building up of the industrial activities of this country are within the country itself. Whatever can be done to further our foreign trade is greatly important, but still more important is the establishment within our own borders of such conditions as will most greatly tend to increase the progress of our manufacturing.

SINGLE PULLEY DRIVES.

WM. F. GROENE.

The editor's request in MACHINERY several months ago for opinions on the "all gear" or "single pulley" drive, certainly relates to a subject on which discussion is timely. The question is one of the most important attracting the attention of machine designers to-day. The writer has recently made an extended tour through all the principal tool shops of the country, and with very few exceptions it is the opinion among builders and users that the single pulley drive will largely supersede the cone drive; and undoubtedly as soon as the present rush of business is over a great deal of attention will be given to tools of this design. Still for certain conditions it is doubtful whether we will find anything better than our old servant, the cone. The two principal advantages possessed by the single pulley drive are:

First, a great increase in the power that can be delivered to the cutting tool owing to the high initial belt speed. The belt speed always being constant, the power is practically the same when running on high or low speeds. The cone acts inversely in this respect; that is, as the diameter of the work increases, for a given cutting speed, the power decreases. As a second advantage, the speed changes being made with levers, any speed can be quickly obtained.

To these might be added several other advantages. The tool can be belted direct from the lineshaft; no countershaft is required; floor space can be economized. It gives longer life to the driving belt; cone belts are comparatively short-lived, especially when working to their full capacity. There are, however, some disadvantages to be encountered. Any device of this nature where all the speed changes are obtained through gears, is bound to be more or less complicated. The first cost of the tool is greater. There is also more waste of power through friction losses. A geared drive requires more attention, break-downs are liable to occur, and for some classes of work it cannot furnish the smooth drive obtained with the cone. Most of these objections, however, should be offset by the increased production obtained.

To the designer the problem presented is one of obtaining an ideal variable speed device, something that mechanics have been seeking for years with but poor success, and it is doubtful whether we will get anything as good for this purpose as the variable speed motor in combination with double friction back gears and a friction head. There are, it is true, some very creditable all-gear drives on the market in which the problem has been attacked in various ways. Still there is lots of room for something better. In the writer's judgment the ideal single pulley drive should embody the following conditions.

1. There should be sufficient speed changes to divide the total range into increments of say between 10 and 15 per cent.

2. The entire range of speeds should be obtained without stopping the machine.

3. Any speed desired should be obtained without making all the intermediate changes between the present and desired speed.

4. All the speeds should be obtained within the tool itself, and no auxiliary countershaft or speed variators should be used.

5. Only the gears through which the speed is actually being obtained should be engaged at one time.

6. The least possible number of shafts, gears and levers should be used.

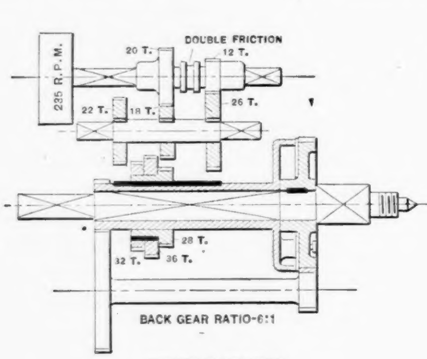
There are few subjects in machine tools which admit of so many combinations, arrangements and devices. The writer shows in Figs. 1 to 6 inclusive, some sketches taken at random from a large collection. All of these, except Fig. 6, have the number of teeth and the speeds marked. Each has some good points but none of them possesses all the points referred to above. The only excuse for publishing them is to show what a vast number of designs can be devised. One of them, that shown in Fig. 1, has been built, a number of machines have been running for over a year, and they give very good results. In Fig. 7 is shown the way the idea was worked out as applied to a 20-inch Le Blond lathe.

[The design for the headstock shown in Fig. 7 needs little explanation since the drawing shows the parts quite clearly.

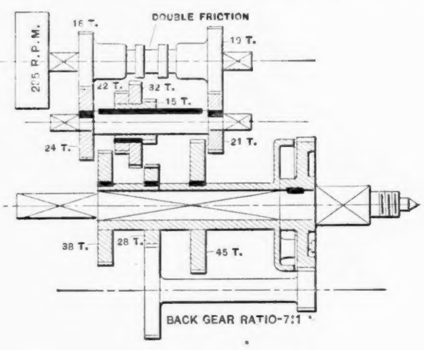
The friction clutch on the driving shaft Z, which alternately engages pinions H and J, is of the familiar type used in the Le Blond double back-geared milling machine. Sliding collar D operated by handle S moves the double tapered key E either to the right or left as may be desired, raising either wedge W or W', which in turn expand rings X or Y within the recess in either of the two cups, F and F'. Either of two rates of speed is thus given to quill gear K and the two gears L and M keyed to it. On the spindle is a triple sliding gear which may be moved to engage P with M, O with L (as shown in the drawing) or N with K, thus giving three changes of speed when operated by lever T. The six speeds obtained by the manipulation of levers S and T are doubled by throwing in the back gears, giving 12 speeds in all.

In comparing the merits of a series of gear drive arrangements like that shown in Figs. 1 to 6, how would it do to apply the "point" system in determining the most suitable one? The number of points that are to be assigned to a device for perfectly fulfilling any one of the various requirements outlined by Mr. Groene would be a matter requiring "selective" control is assigned 10 points. The fourth consideration, requiring that all speeds shall be obtained within the tool itself is a positive requirement. If it is not met, the mechanism is out of the contest, so this question need not be considered in our table of points. Fifteen points are suggested for the requirement that the gears not in use shall not be running in mesh. The sixth requirement reads "The least possible number of shafts, gears and levers should be used." It is suggested that this be divided, giving 20 points to the question of the ratio of the number of changes obtained to the number of movements required of the operator to obtain them, and giving the same number of points to express the ratio of the number of changes obtained to the number of gears used in obtaining them. The sum of these points added together is 100, which may be considered as representing the ideal design.

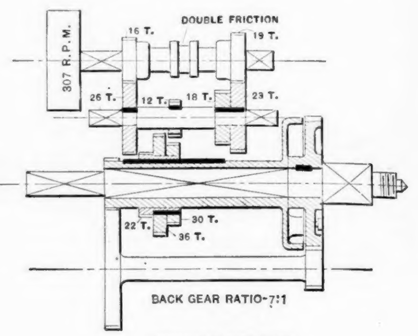
In filling out the table, since No. 1 has only 12 speeds or half the number required, we will give it only one-half the number of points, dealing similarly with the other designs up to No. 6, which is perfect in this respect. The machine has



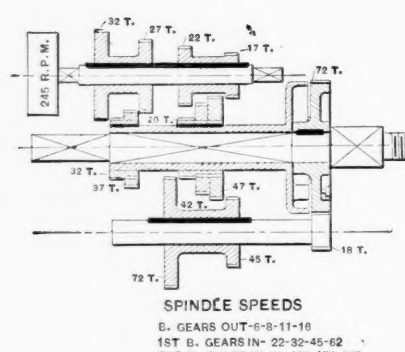
SPINDLE SPEEDS
B. GEARS IN-9.-12.4-16.7-21.6-29.76-40
B. GEARS OUT-54.-74.-100.-129-179-240
FIG. 1



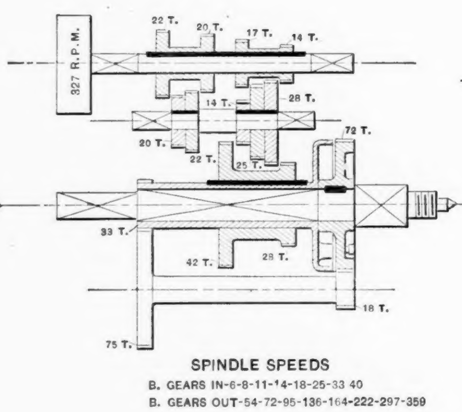
SPINDLE SPEEDS
9-12-16-24-32-48
63-84-112-168-224-336
FIG. 2



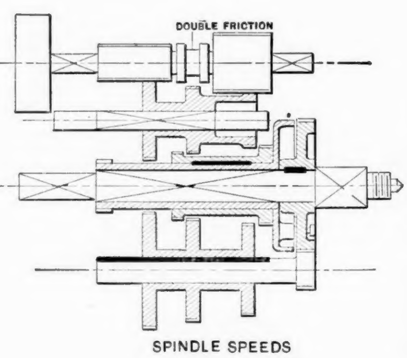
SPINDLE SPEEDS
9-12-16-24-32-48
63-84-112-168-224-336
FIG. 3



SPINDLE SPEEDS
B. GEARS OUT-6-8-11-16
1ST B. GEARS IN- 22-32-45-62
2ND B. GEARS IN-89-128-179-245
FIG. 4



SPINDLE SPEEDS
B. GEARS IN-6-8-11-14-18-25-33 40
B. GEARS OUT-54-72-95-136-164-222-297-359
FIG. 5



SPINDLE SPEEDS
24 SPEEDS OBTAINABLE,
NO DATA GIVEN
FIG. 6
Machinery, N.Y.

Six Examples of Possible Geared Head Arrangements selected at random from a large number of Similar Sketches.

nice discrimination. So the method outlined below is to be taken as being suggestive, rather than authoritative. Our contributor's first requirement is that there shall be sufficient speed changes to divide the total range into increments of between 10 and 15 per cent. The six schemes he proposes do not all, unfortunately for our proposal, take in the same range of speed; considering, however, that they were each to be designed to give from 9 to 240 revolutions per minute to the spindle as in case No. 1, and that a 15 per cent increment is to be allowed, the number of changes required can be found in the usual way by dividing the logarithm of 27—, the total speed ratio required ($240 \div 9 = 27$—) by the logarithm of 1.15, which is the ratio of the geometric series desired. This gives 24 speeds, about, as needed to meet the requirements. Suppose we assign 15 points to a machine having 24 speeds. Let us set this down in its proper place in the table, given on the following page. For the second qualification, that the machine shall not have to be stopped, we may assign 20 points to the ideal machine. The principle of to be stopped to throw in back-gears. Assuming that this would not have to be done in 70 per cent of the changes, we get a uniform value of 14 for this consideration for all the cases. The feature of selective control is only about two-thirds realized in any of these designs, since the triple sliding gear used in all of them, in moving from one extreme to the other, passes through an intermediate position which is not required at the time. We may therefore assign the value 7 to each of these designs on this account. As to the question whether the gears not in use are running idly in mesh, all the designs are nearly perfect. The values set down in this table are suggested by this consideration. In considering the number of movements required to effect the number of changes obtained, the throwing in of the back-gear is credited with four motions, the stopping of the machine, unlocking of the spindle from the gear, the throwing in of the back gears and the starting of the machine. The 20 points of the ideal machine are then multiplied by each of the ratios obtained by dividing the number of changes by the number

of movements and the number of points found are set down as shown. For the last item twice as many changes as there are gears employed is taken as a maximum which can probably not be exceeded. With this as a standard the ratio obtained by dividing the number of changes by the number of gears used is employed to calculate the number of points.

A SUGGESTED TABULATION OF THE MERITS OF THE VARIOUS DRIVES PROPOSED.

Requirements.	Perfect Design.	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
No. of changes required compared with No. obtained..	15	8	8	8	8	10	15
Stopping of machine........	20	14	14	14	14	14	14
"Selective" control........	10	7	7	7	7	7	7
Gears not in use, must not be in mesh........	15	13	13	13	15	15	13
Ratio of No. of changes to No. of movements	20	15	15	15	13	12	14
Ratio of No. of changes to No. of gears.............	20	10	9	9	9	16	18
Total	100	67	66	66	66	74	81

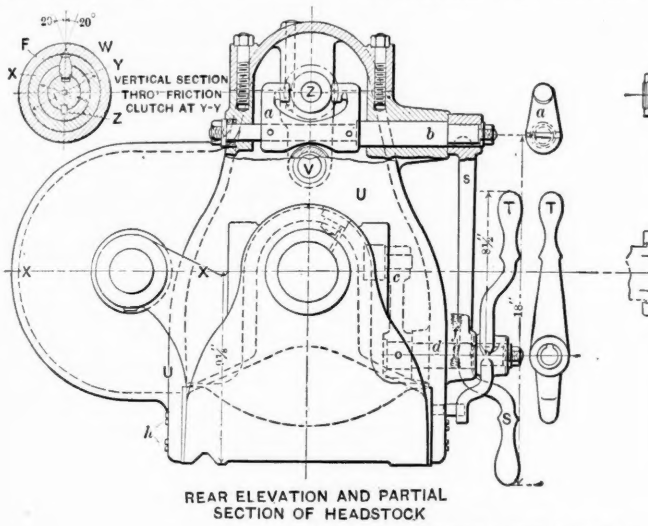
Adding the number of points obtained in each column we find that No. 1 has 67, No. 2, 3, and 4 each have 66, while No. 5 has 74, and No. 6, 81.

The comparison has been undertaken in this way with the understanding that all the arrangements are susceptible of being embodied in a practicable design. That arrangement No. 6 is practicable is strongly to be doubted. Our contributor has not given us the number of teeth in the various gears used, and it is far from probable that he could obtain with this arrangement a series of speeds in geometrical progression by moving in regular order the three levers required. Nos. 4 and 5, while otherwise well arranged, are open to the objection that sliding gears rotating at high rates of speed are used. This, if valid, constituted a disqualifying objection similar to that mentioned in relation to Mr. Groene's fourth requirement. The first three cases in which a friction clutch instead of sliding gears is used on the driving shaft are therefore much to be preferred for this reason. Of these first three cases, our tabulation shows that case No. 1 has a slight advantage, and Fig. 7, in which this arrangement has been applied to a 20-inch lathe headstock, shows that the scheme is a simple and satisfactory one, so far, at least, as one can judge from a drawing.

As before remarked, the suggestion that the merits of these arrangements be tabulated and determined mathematically is a tentative one only and we are willing to withdraw it in the event of determined objections on the part of experienced designers.—EDITOR.]

* * *

So far steam turbines of the Parsons type have been manufactured to give a total of 870,000 H. P. Of this 200,000 H. P. come on American builders, and 350,000 H. P. on the original Parsons' Works in England.



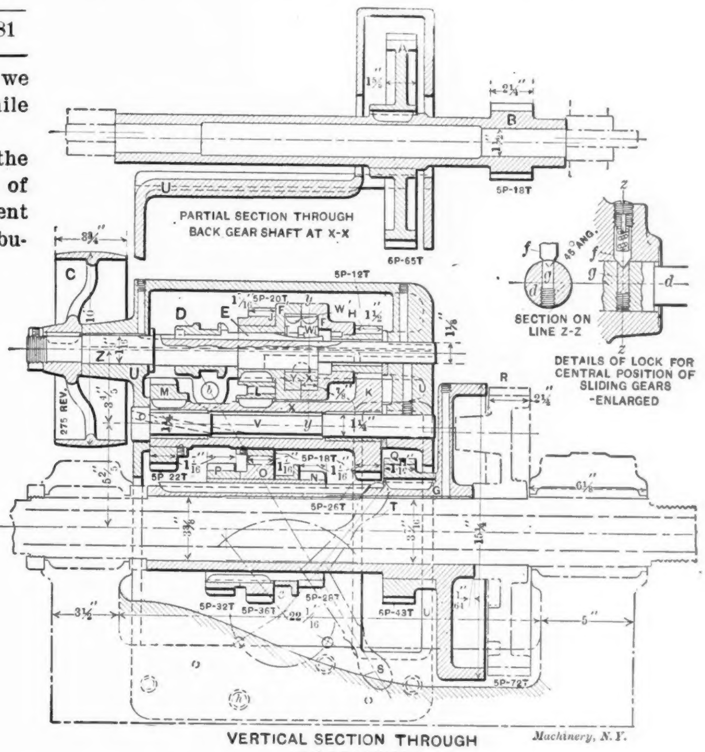


Fig. 7. The Scheme shown in Fig. 1 applied to the Headstock of a 20-inch Lathe.

TAPPER TAPS.

ERIK OBERG.

The name tapper tap as understood by toolmakers and tap manufacturers is applied to one of the two kinds of taps used for tapping nuts in tapping machines. It is often confused with the expression machine tap, which properly designates the second kind of taps used for this purpose; the machine tap, however, differs from the tapper tap in a number of particulars, most important of which are the number and the form of the flutes, the relief of the threads and the general design. The tapper tap is the earlier of the two, and is simpler in its details. It is not adapted for the same hard usage as would be a machine tap, but is largely used for tapping nuts for general purposes in material which is not of too tough a structure.

The general appearance of the tap will be seen from the cut, Fig. 3. It consists of a threaded portion, *A*, chamfered on the top of the thread for a distance, *B*, and a shank, *C*, which as a rule is not provided with a square on the end, this being unnecessary, because the tap is usually held firmly in a chuck by its circular shank. Some manufacturers using these taps prefer, however, to have the shank flatted on two sides, enabling them to secure a firmer hold on the tap in the machine. The diameter of the shank should be at least 0.015 inch smaller than the diameter at the root of the thread, in order to permit the threaded nuts to slide freely over the shank.

In turning and threading tapper taps, as well as any other taps, it must be remembered that the straight part of the threaded portion must be left a certain amount over the standard size. The screw which is to fit the nut threaded by the tap is usually made of a standard diameter, and the nut therefore must evidently be somewhat in excess of this in order to permit the screw to enter and to allow for slight unavoidable differences in the lead of the thread between the screw and the nut. The amount which a tap should thus be left over the standard diameter is largely a matter of judgment, inasmuch as this amount must vary according to whether a tight, free or loose fit is desired between the screw and the nut made by the tap. For general purposes, however, the tap should be made between the limits of from 0.0005 inch to 0.0015 inch oversize before hardening for sizes not over one-half inch diameter, from 0.001 inch to 0.002 inch for sizes between one-half and one inch, and from 0.0015 inch to 0.003 inch for sizes between one and two inches in

diameter. Tapper taps are rarely made in sizes larger than two inches. When larger diameters of taps are required for nut tapping, the taps should preferably be made on the principles of machine taps, the design and making of which the writer will return to in a later issue.

In fluting tapper taps it has been the practice to flute them practically the same as hand taps. It is, however, not necessary to make the lands as wide as on these latter taps, because there is not the same tendency for a tapper tap to deviate from its true course, the tapper tap being guided by the firm grip of the chuck, while a hand tap depends solely upon the lands of its threaded portion for guidance. The fluting of taps is one of the most important factors entering in their manufacture. The correct flute is a compromise between a flute which will give the greatest amount of chip room and the greatest strength to the tap. Besides the flute must be of a shape easily produced, so as to limit the cost as far as consistent with good results, and must carry away the chips from the cutting edges in a manner offering the least resistance. The present practice is to provide tapper taps with deep straight-sided flutes having a small round in the bottom, as shown to the left in Fig. 1. This method, while it provides an abundance of chip room, is accompanied by some very grave disadvantages. The tap will crack more easily in hardening, it will not carry away the chips from the cutting edges as readily, and is not as strong as a tap fluted in the manner shown in the section to the right in Fig. 1. The making and maintenance of the cutters for producing this latter flute, however, is more expensive, and as the present practice of fluting is becoming fairly universal it is evident that the objections, while of a serious nature, do not outweigh the advantages gained. A tapper tap particularly needs plenty of chip room because of its rapid cutting. The radius at the bottom of the flute ought, however, not be less than one-quarter of the diameter of the tap. Some persons well familiar with this kind of work claim that a radius of one-eighth of the diameter of the tap would serve the purpose equally well, besides giving a larger space for chips. It has been proven beyond doubt, however, that this slight difference in the radius at the bottom of the flute influences the endurance qualities of the tap very materially. In regard to the number of flutes there is some difference of opinion. The practice adhered to by prominent tool manufacturers is to give four flutes to all taps up to and inclusive of one and one-half inch diameter, and five flutes for larger sizes. The fluting cutter for straight-sided flutes should have an inclusive angle of 85 degrees, 55 degrees on one side, and 30 degrees on the other, as shown in Fig. 2.

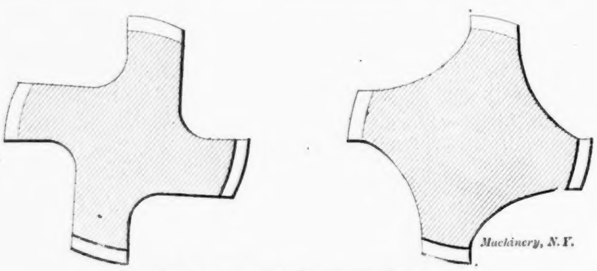


Fig. 1. Different Forms of Flutes.

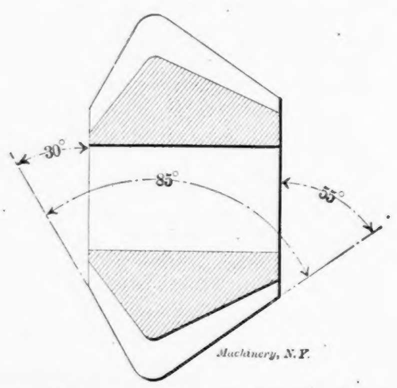


Fig. 2. Fluting Cutter for Cutting Flutes shown to the left in Fig. 1.

The next question of importance is the question of the relief given to the thread. Tapper taps as a rule are relieved only on the top of the thread of the chamfered portion. They are not given any relief in the angle of the thread. The straight part, which performs no cutting, being nothing but the sizing part of the tap, should not be relieved, or, if relieved, the relief should be very slight in order to permit the tap to retain its size so much the longer. It may be remarked that if the tap is backed out through the nut no relief at all should be permitted on the parallel part of the thread, because of the liability of chips getting in between the land and the thread in the nut, injuring tap as well as nut. In hardening these taps they should be drawn to a temper of 430 degrees F.

The accompanying formulas and a table figured from them give the common proportions of length of thread and length of chamfered part of tapper taps. The length over all depends solely upon the kind of work the tap is to be used on. It is the common manufacturing practice to make these taps 11 inches long over all. The formulas are based upon the diameter of the tap as this is the most convenient working factor. It may be objected that the length of thread should rather depend upon the pitch of the thread than upon the diameter. This is true to a certain extent, but if we limit the formulas to standard thread taps, there will be no cause for errors, inasmuch as the number of threads is in all standard systems dependent upon and stands in a certain proportion to the diameter. In the table the values are given approximately as there is no reason to work closer than to one-sixteenth or even one-eighth inch in regard to length dimensions of this character.

DIMENSIONS OF TAPPER TAPS.

D	A	B	D	A	B
$\frac{1}{16}$	$\frac{5}{8}$	$\frac{1}{4}$	1	$3\frac{3}{4}$	$1\frac{1}{2}$
$\frac{1}{8}$	$\frac{7}{8}$	$\frac{3}{8}$	$1\frac{1}{8}$	4	$1\frac{9}{16}$
$\frac{3}{16}$	$1\frac{3}{16}$	$\frac{7}{16}$	$1\frac{1}{4}$	$4\frac{1}{4}$	$1\frac{11}{16}$
$\frac{1}{4}$	$1\frac{7}{16}$	$\frac{9}{16}$	$1\frac{3}{8}$	$4\frac{1}{2}$	$1\frac{3}{4}$
$\frac{3}{8}$	2	$\frac{3}{4}$	$1\frac{1}{2}$	$4\frac{3}{4}$	$1\frac{7}{8}$
$\frac{1}{2}$	$2\frac{9}{16}$	1	$1\frac{5}{8}$	5	$1\frac{15}{16}$
$\frac{5}{8}$	3	$1\frac{3}{16}$	$1\frac{3}{4}$	$5\frac{1}{4}$	$2\frac{1}{16}$
$\frac{3}{4}$	$3\frac{1}{4}$	$1\frac{5}{16}$	$1\frac{7}{8}$	$5\frac{1}{2}$	$2\frac{1}{8}$
$\frac{7}{8}$	$3\frac{1}{2}$	$1\frac{3}{8}$	2	$5\frac{3}{4}$	$2\frac{1}{4}$

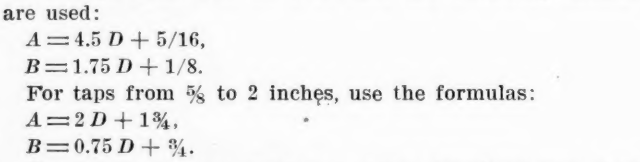


Fig. 3. General Appearance of Tapper Tap.

In the following formulas:

D = the diameter of the tap,

A = the length of the threaded portion,

B = the length of the chamfered portion.

For taps from 1/16 to 9/16 inch the following formulas are used:

$A = 4.5\,D + 5/16$,

$B = 1.75\,D + 1/8$.

For taps from ⅝ to 2 inches, use the formulas:

$A = 2\,D + 1\frac{3}{4}$,

$B = 0.75\,D + \frac{3}{4}$.

The diameter at the small end of the chamfered part should be from 0.005 to 0.008 inch below the root diameter of the thread on sizes smaller than ¼ inch in diameter, for sizes up to one inch about 0.010 inch below, and for larger sizes about 0.015 inch below the root diameter.

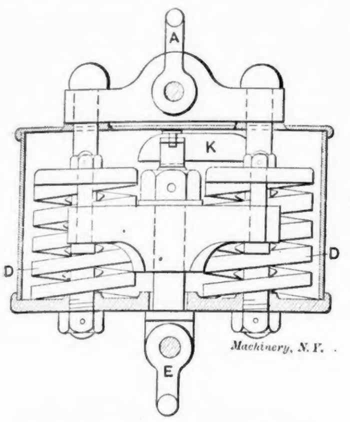
* * *

The bulletin of the Bureau of Labor for July is at variance with the generally accepted theory that prices have increased in a greater ratio than have wages during the last few years. This fact is proven by elaborate statistical tables. Whether the Bureau of Labor is right or not in its contention, may be open to discussion, but the fact remains that no statistical figures will be able to convince the salaried man or the wage earner that prices have not gone up out of all proportion to incomes.

ITEMS OF MECHANICAL INTEREST.

SAFETY DEVICE FOR CRANE CHAINS.

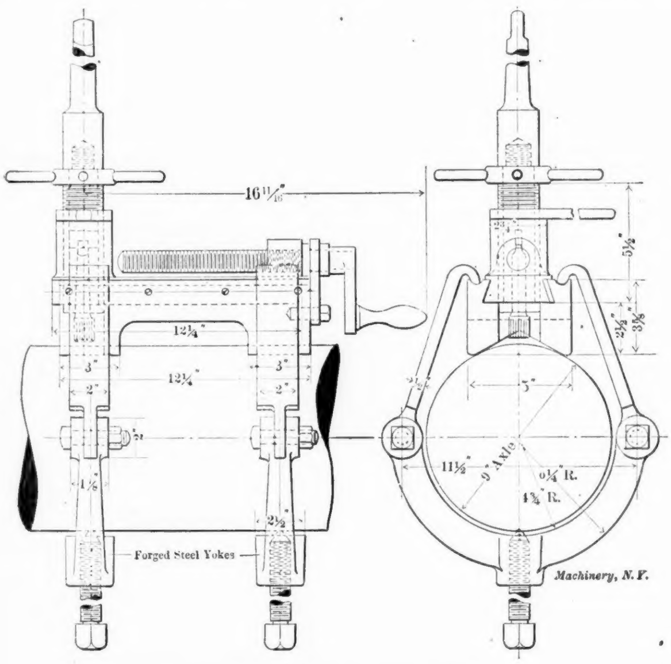
The accompanying cut shows an English device for preventing accidents due to failure of crane chains. These chains have, in many cases, been overloaded beyond their elastic limit, with fatal results. The cut shows an apparatus inserted at a convenient place in the chain, the upper portion of the chain being connected to the hook A, the lower to the hook E. By means of the springs D and suitable connections an electric bell K will give alarm whenever the chain is loaded beyond a certain limit, determined by primary adjustments of the springs and of the electric contacts. The springs, as is seen from the cut, are only in compression, so that any failure of the springs will not cause any damage, the load still remaining suspended. The principle of the design is plainly visible in the cut. The mechanism is dust-proof, being fully enclosed in a casing.



Safety Device for Crane Chains.

LOCOMOTIVE AXLE KEYSEATING DEVICE.

The accompanying cut shows a locomotive axle key-seating tool used in the shops of the Central Railroad of New Jersey, at Elizabethport, N. J., and depicted in the *Railway Master Mechanic*. As seen from the cut the device is fastened to the shaft in which the keyway is to be cut by means of two clamps, each consisting of a steel yoke and two clamping arms, these clamps holding the base of the device in position. A slide is provided which by means of a feed screw is moved back and forth in this base parallel with the axis of the shaft in which the keyways are to be cut. This slide carries a

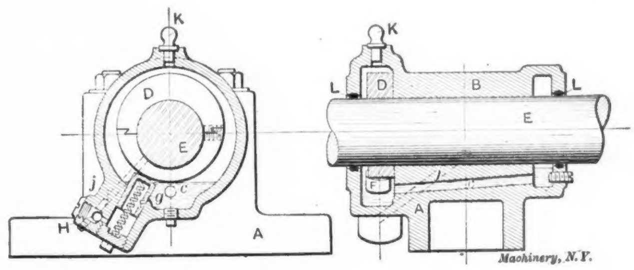


Locomotive Axle Keyseating Device.

spindle bored to receive the Morse taper shank of an end mill, the spindle itself being provided with a Morse taper shank and driven by an air motor connected by a flexible shaft. The device has provisions for adjustments in all directions necessary. The cut shows plainly the design in detail. The usefulness of this tool will be appreciated by anyone who has had to cut out keyways for eccentrics in a hard steel axle, using a hammer and chisel and perhaps doing the job under the engine at that.

A SHAFTING HANGER WITH FORCED LUBRICATION.

At the Olympia machine exhibition, which has been in progress for some months in London, Messrs. Geo. Richards & Co., Ltd., of Broadheath, Manchester, have been showing a pair of swivel adjustable bearings, using a method of self-lubrication, which is illustrated in the line cut of the pillow block shown herewith. A is the main casting of the block and B is the cap. The bearing formed by A and B has an annular recess at each end connected by the duct c. One of these recesses forms a chamber in which revolves split collar D, which is made fast to shaft E with a setscrew and forms one of the collars of the line shafting. The periphery of D is eccentric, and plunger F, which works in a hole in casting A and is pressed against D by the action of a stout spring, is constantly given a reciprocating motion. F is the piston or plunger of the pump which distributes the oil. At the extremity of its upward stroke, ports g are in communication with the reservoir of oil furnished for the supply of



Shafting Hanger with Forced Lubrication.

the bearing. This oil, through the action of a previously produced vacuum below the plunger, is drawn into the chamber beneath it. As the shaft revolves and F is forced downward ports g are closed and the oil within the cavity is pumped out past ball valve H through passage j to the center of the journal, where it spreads over the entire bearing, to the extent that the journal and bearing are kept entirely out of contact with each other. A pressure gage applied to duct j registers from ten to twenty pounds per square inch, depending on the speed of the shaft. As the plug moves upward again under the influence of the spring, the vacuum formed beneath it draws in a fresh supply of oil as soon as ports g are opened. The supply of oil is renewed through plug K. The bearing is made dust-proof and oil-proof by the insertion of leather washers L L at the ends of the bearing. The chamber for the supply of oil has sufficient capacity to lubricate the bearing for several months without any further attention.

* * *

ADAPTING MACHINERY TO THE CAPACITY OF PACK ANIMALS.

One of the problems that sometimes confronts the machine designer is to make the construction so that no part shall exceed a weight of, say, two to three hundred pounds, or that which can be carried by a pack animal. This applies, of course, to mining machinery which has to be transported over mountains and into unsettled parts where roads have not been built. In some cases, however, it taxes the ingenuity to provide this, especially where the machinery is of such a nature that it must necessarily be integral. For example, the steel cables for hoisting have to be transported in full length as much as possible to avoid the defects of splicing. In such cases the matter is up to the manager of the pack train, but the method followed is very simple in scheme, although not always simple in the carrying out—if some of the animals are evil-disposed. It consists simply of uncoiling the cable and recoiling it at intervals to the required burro load, then leading to the next animal, where another coil is gathered, and so on until the whole cable is distributed among as many as are necessary to carry the total weight.

* * *

The postal department in Bulgaria has introduced automobiles for local transfer of mail, and found them to be of great advantage as well as economical for this purpose. It is proposed to extend the employment of automobiles to rural mail routes.

Entered at the Post-Office in New York City as Second-Class Mail Matter.

MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

DECEMBER, 1906.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

RADICAL CHANGES IN MACHINE TOOL DESIGN.

While our department devoted to new machinery and tools overflows every month, it must be acknowledged that of late few radical departures in machine design have been illustrated. The changes noted and the new tools described have, in general, been in the nature of minor improvements, new sizes, etc. Manufacturers who would develop radically new designs, are so busy filling orders for regular stock that they have little time or opportunity for developing new designs to the extent of manufacture. Many of them, we are assured, have laid out interesting departures, which they are "holding up their sleeves" for the time when business shall slack off and give them a breathing spell. It is a well-known fact that ingenuity in machine tool design, as well as in practically all other branches of machine design, is displayed to the best advantage at the time when business is dull. It is poor policy for a manufacturer to stop a profitable output simply to introduce a new idea. His customers want standard tools and want them at once. The time for experimenting is when things are slow, and we shall probably not see many radical departures from present accepted designs until that time.

* * *

CAST STEEL AND STEEL CASTING.

What is the proper designation of material used in a steel casting? It is objected that "cast steel" does not properly apply to any but tool steel or crucible steel, *i. e.*, that made from blister steel—the result of the cementation process—melted in crucibles, poured into ingots, and hammered into bars. The Brussels Congress of the International Association for Testing Materials have compiled a nomenclature of iron and steel, and seek to have it adopted for general use. The designation "cast steel" is defined the same as crucible steel and as obsolescent, therefore to be avoided. This, in our opinion, is unfortunate, for "cast steel" should be properly applied to the state of the material used in steel casting on account of its convenience. We speak naturally of a cast iron object when the material is iron, melted and poured into a mold; why not the same of steel, if it has undergone the same process? There seems little danger of confusion, for anyone who knows anything about the founding and materials of construction knows that a "cast steel" flywheel is not made of tool steel, but of a low carbon steel such as is commonly used for making castings. We are heartily in favor of the adoption of the words "cast steel" to be applied to steel castings and to withdraw its use as applied to crucible steel or tool steel inasmuch as the term has come to be meaningless in this connection.

* * *

WHAT IS ORIGINAL?

It is common to hear that "So-and-so is a copyist; his ideas are not his own, or to put it strong, he is a thief of others' 'thinks.'" But, indeed, few ever do anything that is strictly new. The designer recasts, changes, molds over old ideas into new shapes, and originates hardly ever. He takes what seems good, no matter from whence it comes and makes it his own. How aptly Kipling puts it:

"When 'Omer smote 'is bloomin' lyre,
He'd 'eard men sing by land an' sea;
An' what 'e thought 'e might require,
'E went an' took—the same as me!

"The market girls and fishermen,
The shepherds an' the sailors, too,
They 'eard old songs turn up again,
But kep' it quiet—same as you.

"They knew 'e stole; 'e knew they knowed,
They didn't tell nor make a fuss,
But winked at 'Omer down the road,
An' 'e winked back—the same as us."

But originality is here; the telling of an old story in new words—words known to every one—was what Homer did and Kipling does. So it should be with the building of an idea into metal. Aim, purpose, use should be so evident as to make the user feel that he knows them at sight and could have originated the design—if only he had thought of it in time. It is easy to design the complex, but the simple—never. The complex becomes simple by casting out the useless, and the nearer we get to having only the useful and necessary the nearer we are to the novel and original.

* * *

CHROME STEEL DROP FORGINGS.

One of the things which American manufacturers do not seem to have gotten around to do as yet, is to make chrome steel drop forgings in an expeditious and satisfactory manner. The making of these forgings has become a business of considerable magnitude, owing to their extended use in the better classes of automobiles. The high resilience of this material makes it an almost necessary one for certain important parts of the high grade machine, even though its great first cost and the still more serious difficulty met with in machining it are such as to prohibit its employment under ordinary conditions. In conversation recently with an automobile manufacturer, he stated that it was possible for him to send to the Krupp works in Germany a drawing of a forging and have the order delivered in New York in less time than American manufacturers required to fill orders for similar parts in soft steel. While this is no doubt partly due to the crowded condition in American shops, it is probable that the method of making the dies for forgings of this material has something to do with it. An examination of chrome steel forged parts gives the impression that they are formed in cast dies. While they come to within a fair degree of accuracy in their dimensions, they do not have the smooth, handsome finish we are accustomed to see on work in softer material turned out by machined dies. In fact, experiments with this metal in this country, using machined dies of the usual form, hardened according to the best state of the art, have resulted in the destruction of the dies after very short service. The German manufacturer probably makes a pattern from the drawing, and from this pattern casts steel dies of a composition adapted to the purpose for which they are used. The business of making these dies without doubt involves a high degree of skill in the making of steel castings, a considerable knowledge of the possibilities of the various compositions of steel that can be used for the purpose, and, in addition, requires a complete steel foundry equipment. The business would thus seem to be more nearly in the field of the steel maker than in that of the drop forging manufacturer, with conditions as they now are. Perhaps when the present rush is over, we on this side of the Atlantic may undertake the systematic development of this industry, along with some others in which we have been falling somewhat behind of late.

THE CORRESPONDENCE SCHOOL IDEA.

The celebration of the fifteenth anniversary of the International Correspondence Schools, October 16, at Scranton, Pa., marked a mile-stone in the progress of a great idea—technical education by mail. Like most great movements this started in a very modest way; it originated with Mr. Thomas J. Foster, then the editor of a newspaper in Shenandoah, Pa., who introduced a method of teaching a course by mail which was designed to enable the coal miners of Pennsylvania to pass the required examinations for mine foremen. It included special home study text-books and a system of direction and correction of students' work. The success of this work was immediate, and it led to the formation of many courses, there being now over 200 courses of instruction, covering almost every branch of all the well-known trades and professions. Over 300,000 students have either fully completed courses or have completed various subjects of a course.

The correspondence school idea appeals with special force to men who, as they have come to mature years, have realized their lack of education, especially on technical subjects. To many young men, unfortunately, the word education has an empty sound. It means little to them save perhaps a smattering of the three R's. Having no incentive to wider knowledge and, consequently, few or no ideals, they have drifted along until opportunities or family responsibilities have awakened them to a sense of their need. To such who are truly ambitious the correspondence school idea may be a great help. It opens the door to self-help and explains the way, making it so easy that the ordinary man of average intelligence who is able to read and write can gain a specialized knowledge and an understanding of the theory of his industry which will qualify him to be a leader in it rather than an inferior workman. The practical nature of the instruction and the fact that it treats of the business with which the learner is already familiar, has made this system of education a powerful factor in the general uplift.

* * *

THE ROTARY GAS ENGINE.

In the Engineering Review section of the November issue space was given to an abstract of an article on the above subject without editorial comment. The article was in favor of the gas engine, using the unsound arguments that have been used time and time again to bolster up the case of the steam rotary engine. The strongest feature of the rotary engine and one that always appeals most to inventors is the absence of dead centers and the fact that in the reciprocating engine there is a varying crank effort beginning at zero and increasing up to the maximum at about half-stroke position, then decreasing to the time of exhaust. The rotary engine is held to be free from this "defect"; consequently a great gain of mechanical efficiency is claimed. In the article noted the following unreliable statement is made, bearing out this claim:

"The greatest advantage of the rotary over the reciprocating engine would be, that the power of each impulse is applied constantly on the tangent; hence, the turning moment would be always equal to the pressure at any point, while in the reciprocating type, the turning moment varies for small close-connected engines approximately as given in the accompanying table:

	Pressure.
Beginning of stroke	0.00
1/8 of stroke	0.444
1/4 of stroke	0.668
3/8 of stroke	0.84
1/2 of stroke	1.00
5/8 of stroke	0.75
3/4 of stroke	0.60
7/8 of stroke	0.44
Full stroke	0.00

"This variation is due to the imperfection of the crank and connecting rod as a means of power transmission. The above factors coupled with the constantly varying pressure, which falls rapidly after the beginning of the stroke, make the average turning moment only about 0.45 of the average pressure on the piston. *The rest of the pressure, about* 0.55, *is simply lost in strains and friction*." (The italics are ours.)

To quote Josh Billings, "this is 2 mutch." Did the author stop to consider that although the crank effort does vary substantially as claimed, the piston moves only about two-thirds the distance traversed by the crank, and that the volume swept up by the reciprocating piston is not more nor less than that swept up by the rotary piston for the same number of foot-pounds developed, neglecting friction? And, as to friction, the rotary engine is notorious in this respect. In fact it is the one great defect of the rotary engine, causing excessive wear and low mechanical efficiency. The prospects of success for the rotary gas engine seem even more remote than those of the rotary steam engine. What more could we say against it?

* * *

CONSULAR COMPLAINTS CONCERNING THE HANDLING OF FOREIGN TRADE.

There has appeared of late a great number of complaints from our consular service in regard to the manner in which American manufacturers treat their foreign customers and handle the export trade. These complaints seem to indicate that our European competitors are superior to us in every respect in regard to handling their foreign trade. Whether this supposition is founded on reasonable ground will be a second consideration. In fact it is impossible to review consular reports of any European country without finding that the consuls of those countries make similar complaints regarding the manufacturers of their respective countries. Instead of the American manufacturers solely being at fault it must be that manufacturers all over the world have not as yet acquired the ability of handling their foreign trade in the same expert manner as they take care of their domestic trade relations. We point out this fact, not with a view of impressing upon American manufacturers the opinion that inasmuch as the manner with which they handle their foreign trade may not be in any way inferior to the manner in which our European competitors handle theirs, they should feel satisfied with the results obtained and not try to improve, but simply because we consider that due justice ought to be given to our own country and its manufacturers. While there doubtless is good reason for improvements in many respects it does not seem justified to paint the American export trader fully as black as some of our foreign consuls have succeeded in doing.

There is, however, another complaint made by our consular service which we think to be far more justified, and which should not be disregarded by our manufacturers and merchants. Reports are frequently received from diplomatic and consular officers complaining of carelessness on the part of correspondents in the United States in failing to fully prepay the prescribed postage on letters and other mailable matter. This carelessness is not only annoying but is expensive to those receiving communications upon which the full amount of postage has not been paid, and has resulted in many cases in defeating the sale of American products abroad. It places an unnecessary burden on people who are making an effort to become acquainted with American goods and methods. Being compelled to pay penalties, even though small, does not tend to promote good feeling on the part of actual or prospective buyers. Under international postal agreements a penalty equal to double the amount of deficient postage must be paid by the party to whom the matter is addressed.

In offering a suggestion for overcoming the liability of mistakes in large establishments where all mail is handled by a special clerk it may be well to call the attention to the custom of several well organized houses who use special envelopes bearing the words "Foreign Mail" printed in the place where the stamp is to be affixed. This serves as a constant reminder to the mailing clerks that the domestic postage rates do not apply to the letters or packages so marked, and errors are thus easily avoided. Such a course might help to regain the good will of many foreign firms whose disaffection can be attributed to no greater and no other cause. The evil is evidently due to a lack of proper classification of mail matter in the offices of our merchants, and a simple method, like the one mentioned above, would probably prove to be an effective remedy.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Two-cent letter postage for each half-ounce became effective between New Zealand and the United States on November 1. This arrangement will no doubt bring the two countries into closer business relationship.

Two months ago the first section of the Pekin-Kalgon Railway was opened which will, when completed, connect the Chinese capital direct with Europe and will bring Pekin within twelve days of London. The most remarkable feature in connection with the building of this railway is perhaps that it has been constructed entirely by Chinese men working under a native engineer.

It has been suggested several times in engineering history to make use of the tides by allowing them to fill diked-in territory, to run out again through turbines. It happens, however, that land that can be diked in is very valuable for dairy purposes, as the soft mud makes excellent soil, and much more can be netted from the land than from the power. —*Power.*

A remarkable opinion with regard to steam turbines finds expression in the words of Dr. Riedler at the Berlin meeting of the Society of German Engineers when in discussing the development of the steam turbine he found occasion to say: "The turbine is no longer the motor of the future; it is the steam engine of the present." This opinion has so much greater weight, as Dr. Riedler himself has attained much of his professional eminence by reason of his success in the improvement of reciprocating machinery.

An interesting employment of paper relates to the production of gas-pipes. Manila paper cut in strips, of a width equal to the length of the pipes to be made, is put in a receiver filled with fused asphalt and rolled solidly and uniformly around a rod or core of iron until the desired thickness is obtained. After the pipe thus produced has been submitted to heavy pressure, the exterior is covered with sand and the whole cooled in water. The core is removed and the outer surface covered with a waterproof product. These pipes, it appears, are perfectly tight and more economical than metal pipes.—*The Mechanical World.*

Two parts of aluminum and one part of zinc form an alloy to which has been given the name "alzene." It is equal in strength to good cast iron and superior to it in the matter of elastic limit. It takes a fine smooth finish and does not readily oxidize. The color is white. It melts at a low red heat, and is very fluid, running freely to the extremities of the mold and filling small or thin parts. Great care must be exercised in melting it, particularly when mixing the two metals, in order to preserve its smooth working qualities. It is said to be somewhat brittle and hence unsuited to such pieces as require the toughness possessed by brass.—*Obermayer's Bulletin.*

The Giornale d'Italia, Rome, Italy, announces that the Midvale Steel Company, Philadelphia, has obtained from the Italian government an order for 2,100 tons of armor plate, valued at $1,000,000, for a man-of-war. The American company was in competition for the contract with five European firms, including the Krupps. Its tender was $180,000 less than that of the Italian Terni factory. Comments seem almost unnecessary, but it is evident that the time has passed when fiscal provisions are necessary in this country to keep foreign steel product out of the competition with our own steel mills. The above seems to amply indicate the latter's ability to successfully compete with European steel concerns even if "unprotected."

By reason of the ease with which the rotating member of a turbine revolves in its bearings, and the length of time that it will continue to run after the steam has been shut off, the frictional work of that form of engine is assumed to be very small. C. H. Wingfield calls attention to the fact that while there is no doubt about the friction *per revolution* being much less than in a reciprocating engine of equal power, the number of revolutions in a given time is much higher, and the friction of the turbine must be proportional to this greater number of revolutions before a comparison can be made. In other words, he asks, "Is the work expended per minute in overcoming friction less with a turbine than with a slower-running reciprocating engine of the same power?"—*Power.*

A two-cylinder 20-horsepower Maxwell automobile made a 3,000-mile run without its motor ceasing operation, the test ending in New York, October 31. The most of the mileage was made between Boston and Worcester, the round trip being 88 miles. This route was covered by two drivers, alternating at the end of every two trips. Then, in continuation of the run the car traveled to New York, back into Connecticut and again to New York, so as to complete the 3,000-mile distance. For fuel and lubrication 161½ gallons of gasoline, at 20 cents per gallon; 24¼ quarts of lubricating oil, at 20 cents per gallon; and 5 pounds of grease, at 15 cents per pound, were used. Other minor expenses brought the total nominal cost of operation for 3,000 miles up to $41.45.

As was mentioned in an article describing the new shops of the Western Electric Co. at Hawthorne, Ill., in the July issue of MACHINERY this company has provided storage bins for coal so arranged that the coal may be kept stored under water, this for preventing loss of heat units and spontaneous combustion. For the storage bins a plot 320 x 75 feet has been excavated to a depth of about 12 feet and lined and sub-divided by concrete walls into twelve 80 x 25 feet pits. The bottom is clay subsoil and the walls are carried about 4 feet above the ground. The pits can be flooded by means of a 12-inch water main. The longitudinal division walls are wide enough to carry the tracks on which the coal is delivered. It is removed from the pits by a steam shovel.

There has of late been a number of different formulas proposed for the rating of automobile motors. The Automobile Association of Central Europe has adopted a formula for four-cycle motors based upon a mean pressure of about 55 pounds per square inch and 900 revolutions per minute. This formula reads $N = 0.003\ id^2s$, in which N equals the number of horsepower to be determined, i the number of cylinders, d the diameter of the cylinders, and s the stroke. All dimensions are given in centimeters. If the dimensions are given in inches the formula would be $N = 0.0492\ id^2s$. The output as figured from this formula is rather low, however, depending upon the low mean effective pressure upon which the formula is based.—*The Horseless Age.*

After the great San Francisco fire, hundreds of tons of lead, zinc, and other metals owned by the Selby Smelting Company were found melted into a solid block at the base of the shot tower that was for many years one of the landmarks of the old city. The problem of recovering the metals, which were worth many hundreds of thousands of dollars, was a difficult one. The great mass could not be raised or broken up into fragments of a practicable size by any ordinary means. After removing several tons of bricks and débris, however, channels have been cut through the great block of metal by an electrical arc process. The bed of metal is from three to four feet thick, and covers the entire area of the ruins of the tower. The heat and light produced by the process are intense, though only ten volts are used for each implement. The men who are engaged in cutting the channels have their heads and faces covered with canvas to protect them from the blinding light. The metal is recovered in blocks weighing nearly a ton each.—*Scientific American.*

The opinion has frequently been expressed that Scandinavia, with its huge waterfalls, will before long be one of the most suitable places for large chemical works; indeed, it is claimed that with the future developments of electrochemical technology the greater part of the world's supply of soda, chlorates, nitrates, calcium chloride, and iron will be produced in the northern peninsula. Hence it is easy to understand the action of the Swedish and Norwegian governments in protecting the falls against foreign capitalists. Sweden has passed a law that the use of the falls is reserved to the State, while a bill is before the Norwegian Storthing in which it is prescribed that at least one-half of the capital laid out on the falls shall be Norwegian money, and the direction of the work be in the hands of Norwegians who are living in the land.—*London Nature.*

It is a common thing to find that many of our modern inventions and developments have been thought of a long time ago, but on account of various causes been forgotten. It may, however, surprise many, that a typewriter was invented and made two hundred years ago, during the reign of Louis XIV, in France, by one of his officials. The apparatus contained some of the principal details of our modern typewriters. Another fact of similar character is called to our attention by *The Engineering Magazine* for October, where we are told of the existence of a Scott graphophone in the "Musée du Conservatoire des Arts et Métiers" in Paris, the construction of which probably antedated the birth of Edison. Such cases do not decrease the honor of individual inventors, but only serve to prove that the human mind has constantly been active to solve certain problems which it has been reserved for our time to bring to a practical solution; that in fact, "nothing is new under the sun."

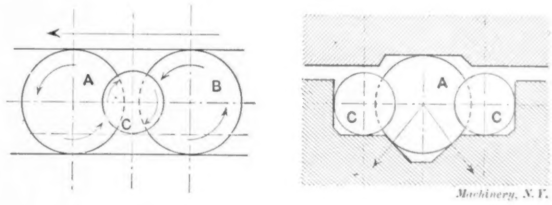
While the development of the use of steel cross-ties for railroad construction has not been very rapid in the United States, it may be of interest to know that metal ties were discussed in Germany as early as in the sixties, and that seventeen years ago nearly 10,000 miles of German railroad was laid with iron or steel foundation. In 1903, 11,500 miles of track were provided with metal cross-ties, this constituting more than one-fourth of the tracks in Germany. Indications point to the fact that the railroads in this country will before long earnestly consider a step of this kind for many reasons, among which we may mention the electrification of roads, necessitating a third rail and its supports, the abolishing of the grade crossings, calling for an abundance of viaduct work, and automatic train signalling which may call for a stronger support than can be provided for by wooden ties. It is evident that the expense of construction of railroads will increase with this improvement, but the traffic of the country is also increasing in such a degree that if the German railroads are able to afford this expense, there is no question but what the permanence of the track which this improvement would insure, will amply repay the railroads in this country for the increased amount of investment necessary.

THE CRYSTALLIZATION OF STEEL.

In an article in the *Iron Age* Mr. James H. Baker treats the subject of annealing and crystallization of steel. His statements in regard to the latter subject are very interesting. He claims that while there has been a great deal said about steel crystallizing when in use or when subject to vibrations and shocks, there is still room for doubt on this point. During experiments carried on by Mr. Baker, he has hammered steel for a long time cold and bent it back and forth slowly under a press until nearly destroyed, and on cutting and breaking the pieces there was no sign of crystallization. He claims that at times when steel used for industrial purposes breaks, as all things will when used enough, and its fractured area shows a crystalline structure, then it is always said to be "crystallized by use." But the fact is that the steel which when breaking shows a crystalline structure has been sent out from its place of production in a crystalline condition originally, and its use simply separates the faces of the crystals. Shortly, Mr. Baker seems to claim that there is no such thing as the crystallization of steel from shocks or vibrations. Cases where such occurrences have been suspected simply reduce themselves to a case where the steel has been defective from the beginning.

IMPROVED BALL BEARING.

The principle of spacing the individual balls of a ball-bearing by means of a second set of balls which carry none of the load of the bearing but serve only as spacers, has been applied in a new way by Mr. E. Denis, of St. Quentin, near Paris, France. Two sets of spacing balls are used, one on



Principle of Improved Ball Bearing.

each side, and tracks are provided for them to bring them central with the larger main balls. The sketch herewith, taken from *Le Genie Civil* shows the arrangement so fully as to require no further explanation. This form of bearing has been applied to the step-bearings of centrifugal dryers.

THE VALUE OF ALCOHOL FOR COMBUSTION ENGINES.

The Engineer, November 1, 1906.

With the enactment of the law on denatured alcohol, which is to take effect on January 1, 1907, experimental data on engines adapted to use this fuel are in order. The Model Gas Engine Works of Peru, Ind., have already had engines operating successfully with this fuel for a little more than a year. To adapt the "Model" engines for alcohol required no change whatever, with the exception of the compression, the fuel being admitted over a disk valve, thence passing through screens of perforated brass direct into the cylinder.

For its experimental work, the company used alcohol exported from Cuba. The company paid 10 cents a gallon, but was obliged to pay duty until it cost something over $3 a gallon delivered.

On trial it was found that alcohol was not nearly so volatile as gasoline, and therefore would stand a much higher compression. Various compressions were tried until a little more power was secured from a given sized engine than was possible with gasoline, the increase amounting to almost 10 per cent. The engine ran much more smoothly with alcohol, and there was no tendency for the heavy jar at the time ignition took place usually found in gaosline engines of high compression. This was accounted for largely in that the alcohol did not burn so rapidly.

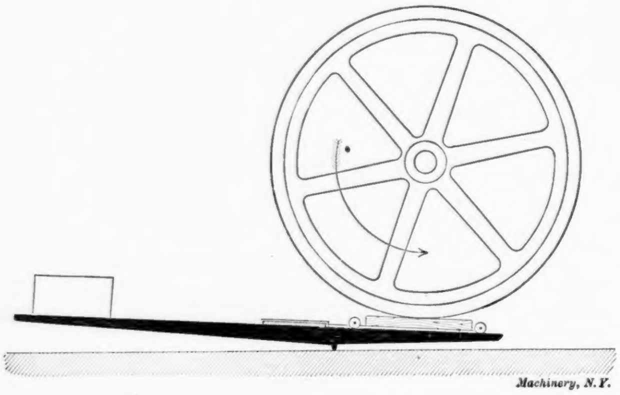
Very little difference was found in the consumption of alcohol as compared with gasoline. For the low grade alcohol which was tested the consumption was found to be approximately 1 gallon per horsepower for 10 hours, and this is practically the same result as secured with gasoline. Some writers are claiming that 1 gallon of alcohol will go as far as 2 gallons of gasoline for power purposes, but it is the company's belief that these people are not talking from actual experience, or have experimented with a higher grade of fuel than used by them.

It was also found that the engine would start practically as easily with alcohol as with gasoline, and was free from smoke and dirt. On the whole, the experiments seem to point out that alcohol is preferable to gasoline for power purposes with the gas engine, from almost every standpoint, where the price of both are equal.

A NEW DYNAMOMETER.

The Practical Engineer describes a very simple dynamometer recently brought out by an English concern. The object of the invention is to provide a measuring brake, which is portable and self-contained, and can be applied instantly to any engine or motor without previous preparation, and by which the power absorbed can be accurately and immediately meas-

ured with as little calculation as possible. This dynamometer, known as the Sellers, consists of a long lever carrying at one end a brake block running on small flanged wheels and attached to a spring balance fixed to the lever, as shown in the cut. The instrument can be used directly upon the flywheel. When not in use the brake is perfectly free of the flywheel, a great advantage when starting the engine or motor. The load is applied either by pressure of the foot or by placing



A New Dynamometer.

a weight on the long end of the lever, this weight being moved along to give a nice adjustment for steady running. There are no allowances or corrections whatever to be made, and by means of the table supplied with the spring indicator the power developed may be read off at once without any calculations.

THE STRENGTH OF IRON CASTINGS USED IN MACHINERY.

At the convention of the American Foundry Foremen, Professor C. H. Benjamin read a paper on the strength of cast-iron machine parts, in which he gave the results of many tests that have been made by him to determine by actual experiment the strength of castings of different forms. The information given by Prof. Benjamin will be found of decided value to designers, specially when engaged in developing some apparatus in which to save weight, or for some other reason, it is necessary to cut very close to the mark. In the following we have gathered what appear to be the most important parts of his address.

"In so simple a thing as a cast-iron beam of rectangular section, theory is more or less at fault in predicting the safe load. A series of experiments which I conducted several years ago showed me that the neutral axis of such a section was not stationary, but traveled gradually up from the center of gravity as the load increased. As the sections become more complicated the stresses due to the uneven cooling begin to appear and to still further embarrass the designer.

In the past dozen years I have conducted tests on a great variety of cast-iron members to determine the actual breaking load or pressure and compare it with that deduced by theory. There were tested in this way beams of various sections, cylinders, wheels, flat plates, gear teeth, pulley arms and rims, flywheels, rotary disks and high-speed pulleys of various types.

Cylinders usually break in a circular line just back of one of the flanges instead of splitting, as theory would indicate. Furthermore, the failures occur at pressure less than one-half those given by the usual formulas for their shells. This is probably due to pressure of blowholes or hot spots at the junction of shell and flange and to the bending moments caused by the pull of the cover bolts. Subsequent tests on cylinders whose flanges have been reinforced by brackets substantiate this conclusion. The cylinders all split from end to end under a pressure approximately two-thirds that given by the formula for their shells. The other third is accounted for by the bending due to lack of uniformity in the metal. A cylinder 10 by 20 inches, with a ¾-inch wall, would burst at a pressure of about 1,400 pounds per square inch, corresponding to a tensile stress of 10,000 pounds, whereas tensile tests showed the metal, a soft gray iron, to have a tensile strength of 14,000 pounds. Rectangular and square plates were tested, and the results were found to be remarkably uniform. The bursting pressure varied less than 10 per cent from that calculated by accepted formulas. The tests on gear teeth were made by applying a steady load on the testing machine, and were only conclusive as to the selection and not the absolute strength of different forms. The pressure was applied at various angles of obliquity, from 0 to 30 degrees, and two-pitch involute and cylindrical teeth were selected for experiments. The shapes varied from those of pinions to those of racks, and the following conclusions were reached:

1. The plane of fracture is approximately parallel to the line of pressure, and not necessarily at right angles to the radial plane.

2. Corner breaks are likely to occur even when the pressure is uniformly distributed.

3. Rack teeth are about twice as strong as those of pinions of 15 to 20 teeth, and involute teeth are from 40 to 50 per cent stronger than cycloidal.

The breaking pressure corresponded quite well to those calculated from the modulus of rupture of the iron used.

In testing the arms and rims of pulleys a steel belt was used, and a twisting moment thus applied to the pulley through the medium of levers and a testing machine. The pull on the tight side of the belt was graduated to twice that of the slack side, and the pulls were increased until one or more of the arms failed. The arms were slightly tapering and had twice the strength at the hub as at the rim. The fact that they broke sometimes at one end and sometimes at the other showed the ratio of the bending moments. The arm or arms nearest the tight side of the belt nearly always failed first, and we were justified in forming the following conclusions:

1. That on account of the springing of the rim the bending is unevenly distributed, so that about twice the average moment comes on the arm nearest the tight belt.

2. That the bending moment at the hub is about double that at the arm, as such pulleys are usually designed. The above ratios will be affected by variations in the relative stiffness of rims and arms.

Tests of Rotating Pieces.—The most fascinating and the most spectacular series of experiments have been those in which rotating pieces have been tested to destruction by high speed.

Wheels, models or flywheels without flanges were operated at a speed up to 400 feet per second, while those made in sections reached the speed of only 150 feet. Placing the joint close to the spoke did not appreciably strengthen the wheel, although steel tie rods between the joints and hubs increased the strength to some extent. English wheels, built on the bicycle wheel pattern, were the strongest wheels experimented with, giving a speed of 4,000 revolutions per minute. The large number of spokes permitted of no bending of the rim. All of the wheels experimented with were 24 inches in diameter.

A balance weight weighing 3½ pounds was located inside of the rim, and the wheel burst at 1,200 revolutions per minute. It should have withstood a strain of 2,000 revolutions.

From these tests we reach the following conclusions:

1. Any weight on the rim between the arms of a rapidly-rotating wheel, whether it be a flange, a balance weight or otherwise, is a source of weakness and danger.

2. When the weight is accompanied by a joint or any breaking of the metal at such a point the wheel is entirely unsafe at even ordinary belt speeds.

3. Solid rims of cast iron as ordinarily designed are almost entirely free from bending stresses, and will not burst at speed much less than 400 feet per second.

Tests on cast-iron disks have just been commenced, and so far the difficulties have been found greater than in any other series of experiments. The bursting speed of a disk is from one and a half to two times that of a ring, and this high speed, coupled with the severe shock of bursting, has affected the steam turbine used in making the experiments. So far three 18-inch disks have been burst at a speed of about 7,500 revolutions per minute. This corresponds to a rim speed of about 600 feet per second and to a stress near the center of about 12,000 pounds per square inch."

ANNEALING UNDER GAS.

Walter J. May, in *The Practical Engineer*, September 28, 1906.

Finished steel articles which have to be kept bright when annealed are rather difficult to deal with when charcoal packing is used, but when the annealing case or box is kept full of ordinary coal gas the trouble is overcome and the articles remain both bright and clean. The process is by no means an expensive one, while with ordinary care there is no danger attendant on working, no extremely high temperatures being required for annealing only. The quantity of gas used is small, as after the annealing case is filled, only a very small quantity need be passed through—enough to keep a No. 0 ordinary fish-tail burner alight being sufficient, and this would probably not be more than 2 cubic feet per hour. The time taken in the process of annealing from start to finish should not exceed two or three hours as a rule unless the articles dealt with were very heavy, and therefore it is scarcely likely that so much as 10 cubic feet of gas would be used in any one case.

Where the operator can regulate the heat it is possible to blue steel articles effectively, but as a rule this would require the use of a pyrometer, as a great number of men

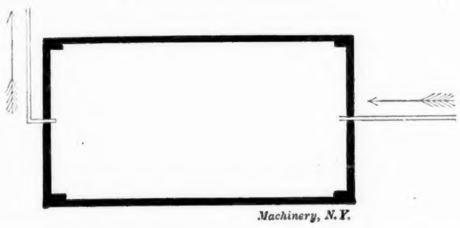


Diagram of Flask and Gas Supply for Annealing under Gas.

could not judge so low a heat as given from 520 degrees F. to 600 degrees F., as there would be no redness to go by. Clear mica sight holes might, of course, be used, but as the annealing flask would be dark inside, these would be of very little use in practice, while test wires would not advance matters much, as these would be blued before larger pieces of metal showed any change in color.

The method of heating the annealing flasks will be the one usually adopted in any particular place, but special flasks would have to be provided, whether they be of metal or fireclay. Probably those of cylindrical form would be best for many reasons, but this form is not absolutely necessary, as rectangular shapes may be more easily dealt with in some places. Anyhow, the same general plan for arranging the gas supply and the small exit pipe will be adopted, and this is approximately shown in the cut, each form of flask requiring its own special arrangement of fittings. Roughly, the flask is filled with the articles to be annealed, the cover luted on, and then it is placed in the furnace, after which the gas is connected and turned on, the air escaping by the exit pipe, which should be fitted with a No. 0 or No. 1 ordinary *iron* fish-tail burner. When the air has been driven out, the burner should be ignited and the supply of gas regulated to give just a small flame at the burner, and as the flask becomes hot probably a further reduction of the gas supply will be necessary. When the annealing is completed the gas supply will be disconnected, and the end of the supply pipe stopped, the exit pipe being stopped as soon as the flask is withdrawn, and then the whole can cool down before opening the flask, the articles not being exposed to the oxidizing influence of the air. Both for convenience and also economy in gas, it is well to have an *iron* stopcock on the exit pipe and an ordinary stopcock on the fixed portion of the inlet pipe, as by this means the flask can be sealed before it is taken from the furnace. This is a matter of detail which should be left to the common sense of the operator, however, and is scarcely worth mentioning where practical men are concerned.

Air must not be admitted to the annealing flasks while they are hot, or the gas will ignite, and under certain conditions explode with some violence, in which case damage would be done both to the furnace and to persons around, in all probability. All joints should be luted to prevent the admission of air as a matter of course, but the luting material will vary with the material of which the flask is made. The heat required for successful annealing, being between 1,300 and 1,500 degrees F., would be sufficient to ignite gas holding a certain proportion of air, but if air is not present the gas will only expand without ignition, and for this reason ordinary care must be used. Taken all round, for bright steel work, annealing under gas presents considerable advantages, but for rough work where finishing has not been done, the ordinary process is sufficient as a rule, and need not be deviated from unless for some special reason.

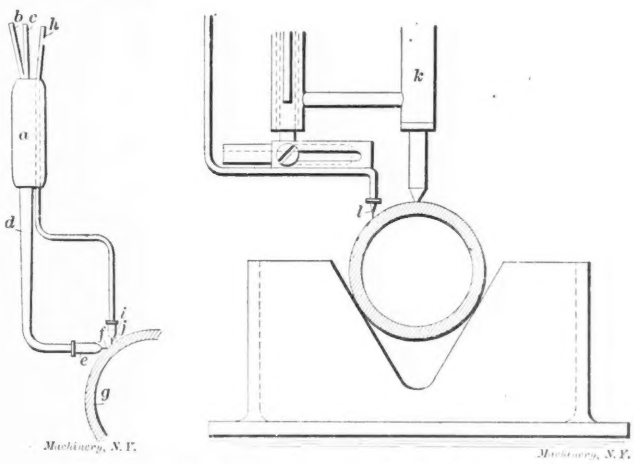
THE CUTTING OF STEEL BY THE COMBUSTION PROCESS.

S. D. V. Burr, *Iron Age*, November 1, 1906.

We are indebted to a Belgian engineer, Felix Jottrand, of Uccle, for the perfection of a process which, according to reports that have reached this side, is both rapid and economical and further is capable of wide application. The process depends upon the union of oxygen and iron and is founded upon the principle that when combustion has once been started it will continue as long as the proper conditions are maintained (see MACHINERY, Engineering Edition, July, 1906, page 590).

The first experiments were made with an oxy-hydrogen flame to bring the metal to a red heat; when this temperature had been reached the hydrogen supply was reduced and that of the oxygen increased, the idea being to produce combustion. It was found that this action was not violent enough; the oxidation was too slow, and the metal could not be made fluid enough to flow freely from the cut. Carried out in this manner the operation was intermittent. Combustion could only be maintained for a few seconds at a time and then the metal had to be again heated with the oxy-hydrogen jet. The kerf was of varying widths and its edges were rough, while the repeated heatings were too prodigal in the use of hydrogen.

Success was attained when two jets, one carrying the oxygen and hydrogen and the other the oxygen, were moved



Figs. 1 and 2. The Cutting of Steel by the Combustion Process.

along the mark. The first brought the metal to a red heat and the second provided the oxygen for combustion. The first jet was kept a short distance in advance of the second. Under these conditions the heat did not have time to be dissipated and the oxide was very fluid. Rapidity of cutting was assured, as the work was continuous. The expense of cutting was reduced, as there was no waste of gases, both the oxygen and hydrogen being used under the most efficient circumstances.

It is explained that the cutting of the metal is affected by a chemical action upon the heated part, the metal being raised to such a temperature as to enable oxidation to take place without fusion of the metal, while the oxides, which are more fusible than the metal itself, flow readily. The severance is perfectly clean as though the metal had been sawed.

The construction of the device will be understood from the accompanying illustrations, which are taken from the patent papers. When the work does not require any great degree of

precision, or when the contours to be cut are quite complicated, an ordinary blowpipe is employed, indicated at *a* in Fig. 1. This is provided with separate inlets *b* and *c* for the oxygen and hydrogen which open into the mixing chamber, *d*, from which leads the nozzle *e*, whence issues the heating jet *f* against the metal *g*. To this blowpipe is fixed the pipe *h*, which conducts oxygen under pressure to the nozzle *i*. This nozzle is arranged to follow closely in the path of the first, so as to direct its jet *j* upon that portion of the metal which has been brought to the proper temperature by the flame. This jet of oxygen produces a clean cut along the line and without appreciable loss of metal.

The second drawing, Fig. 2, shows the nozzles carried by a center *k*, which is applied to a pipe. It is evident that the same arrangement can be applied to a plate for circle cutting. Extending from the center is an arm at the lower end of which is a stud engaging with a slotted bar to which the gas pipes *l* are attached. By this means the device can be arranged to cut in circles of different diameters.

It is mentioned that the section cut is as clean as that left by a saw and the kerf is not over 2 millimeters (0.078 inch) wide in a plate 100 millimeters (3.93 inches) thick. The rate of cutting is 20 centimeters (7.87 inches) per minute for a plate 15 millimeters (0.59 inch) thick. The consumption of hydrogen and oxygen for this amount of work is only a few liters (1 liter = 61.022 cubic inches) of each. The line of cutting may follow any direction desired, and variations in the character of the metal have no influence on the cutting. The process is equally applicable to hard or soft steel and has been advocated for the dressing of armor plate.

HIGH-SPEED STEELS FOR WOODWORKING.

Iron Age, November 1, 1906.

Builders of woodworking machinery assert that they have demonstrated to their complete satisfaction that the high-speed steels are destined to bring about radical improvements in the woodworking industry, and some even go so far as to prophesy that it will be revolutionized in the near future. The tests made by one of the best-known and largest of the woodworking machine establishments brought out these general facts:

The rate of feed may be nearly doubled.

The cutting knives keep an edge from three to ten times as long as the old steels.

The knives may be ground with a better edge.

The sharpening of knives may be done to advantage without removing them from the head.

A slower speed of knife head is entirely practicable.

The most interesting and probably the most unexpected advantage obtained from the use of the new steels is the smoothness of the finish which they give to the work. This seems somewhat paradoxical to one who has employed them in working metal where they have been of little or no value in finishing work, though of exceedingly great importance in heavy or rapid production. Tests made, however, tend to show that in planing, for instance, it is possible to obtain, instead of a succession of knife marks, a clean, unmarred surface with a glossiness similar to that obtained in a sanding machine. Sample boards planed at the rate of 105 feet per minute showed this characteristic, and these boards included several varieties of both hard and soft woods. Sixty feet per minute is a high feed for carbon steels. Probably the reason for this better finish lies in the durability of the steel, which renders it possible to give the knives a keener edge with the knowledge that they will stand up to the work for a reasonable length of time. It is hoped by those who have experimented in this direction that under the new conditions still finer surfaces may be turned out by the planing machine at high rates of feed. As to the use of this steel for heavy reduction purposes, there should be some advantage in employing it as there is in metal working, but not so great a one. Here the old steels have been entirely satisfactory and seldom has a task been found beyond the temper of the cutting blades. For special purposes, such as in machining very hard woods, high-speed steel should prove valuable. As for the form of the knives, the toolholder is coming into vogue, the blades consisting of a thin, narrow strip, securely clamped to the head.

ELASTIC COUPLINGS.

Some kind of a spring drive has long been recognized as advantageous for machinery in which sudden and violent changes of resistance have to be overcome. The cut, Fig. 1, shows a coupling designed by Messrs. Rankin, Kennedy & Sons, Glasgow, primarily for use in motor cars and similar designs, and described in *Engineering* October 12, 1906. Its peculiar feature consists of a rubber disk for transmitting the power. This disk is provided with holes which receive

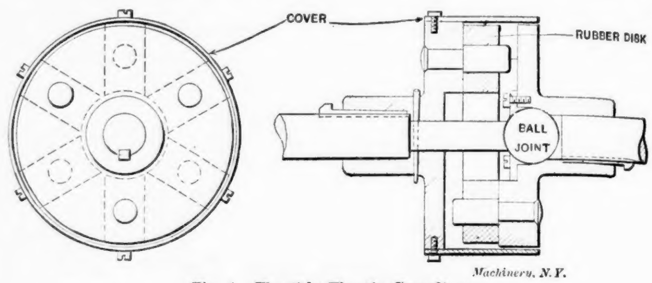


Fig 1. Flexible Elastic Coupling.

the driving and driven pins projecting alternately from the faces of the coupling flanges. There are three pins in each flange. The flanges are prevented from longitudinal movement by a ball-and-socket connection. Consequently the shafts are free to adapt themselves to any want of alignment, but the ends cannot separate or close up on account of the ball joint. In motor cars where gear wheel transmission is used, the Kennedy coupler fitted to each end of the cardan shaft provides both a flexible and spring drive, and acts as a universal joint at the same time.

For chain drive the ball joint is dispensed with, as no flexibility is then required, and the coupling is designed as is

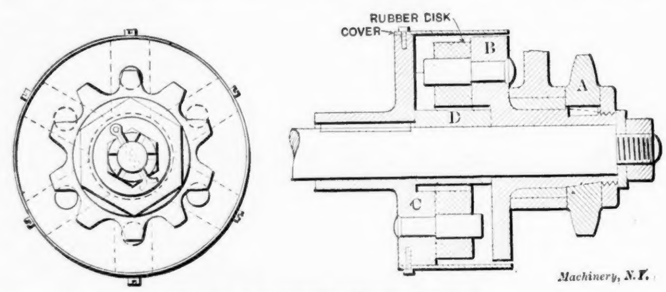


Fig. 2. Non-flexible Elastic Coupling.

shown in Fig. 2. Sprocket wheel *A* is fixed to the sleeve *B*, which turns loosely on shaft. The sleeve *C* is keyed to the shaft and each of the sleeves has three pins connecting them with the rubber disk. The collar *D* is inserted between the sleeves simply to keep them at a correct distance from one another.

UNIFORM NOMENCLATURE OF IRON AND STEEL.

At the Brussels Congress of the International Association for Testing Materials held in September, 1906, a report was presented on "The Uniform Nomenclature of Iron and Steel." The following definitions of the most important forms of iron and steel are given:

Alloy cast irons: Irons which owe their properties chiefly to the presence of an element other than carbon.

Alloy steels: Steels which owe their properties chiefly to the presence of an element other than carbon.

Basic pig iron: Pig iron containing so little silicon and sulphur that it is suited for easy conversion into steel by the basic open-hearth process (restricted to pig iron containing not more than 1.00 per cent of silicon).

Bessemer pig iron: Iron which contains so little phosphorus and sulphur that it can be used for conversion into steel by the original or acid Bessemer process (restricted to pig iron containing not more than 0.10 per cent of phosphorus).

Bessemer steel: Steel made by the Bessemer process, irrespective of carbon content.

Blister steel: Steel made by carburizing wrought iron by heating it in contact with carbonaceous matter.

Cast iron: Iron containing so much carbon or its equivalent that it is not malleable at any temperature. The committee recommends drawing the line between cast iron and steel at 2.20 per cent carbon.

Cast steel: The same as crucible steel; obsolescent, and to be avoided because confusing.

Cemented steel: The same as blister steel.

Charcoal hearth cast iron: Cast iron which has had its silicon and usually its phosphorus removed in the charcoal hearth, but still contains so much carbon as to be distinctly cast iron.

Converted steel: The same as blister steel.

Crucible steel: Steel made by the crucible process, irrespective of carbon content.

Gray pig iron and *gray cast iron:* Pig iron and cast iron in the fracture of which the iron itself is nearly or quite concealed by graphite, so that the fracture has the gray color of graphite.

Malleable castings: Castings made from iron which when first made is in the condition of cast iron, and is made malleable by subsequent treatment without fusion.

Malleable iron: The same as wrought iron.

Malleable pig iron: An American trade name for the pig iron suitable for converting into malleable castings through the process of melting, treating when molten, casting in a brittle state, and then making malleable without remelting.

Open-hearth steel: Steel made by the open-hearth process irrespective of carbon content.

Pig iron: Cast iron which has been cast into pigs direct from the blast furnace.

Puddled iron: Wrought iron made by the puddling process.

Puddled steel: Steel made by the puddling process, and necessarily slag-bearing.

Refined cast iron: Cast iron which has had most of its silicon removed in the refinery furnace, but still contains so much carbon as to be distinctly cast iron.

Shear steel: Steel, usually in the form of bars, made from blister steel by shearing it into short lengths, piling, and welding these by rolling or hammering them at a welding heat. If this process of shearing, piling, etc., is repeated, the product is called "double shear steel."

Steel: Iron which is malleable at least in some one range of temperature, and in addition is either (*a*) cast into an initially malleable mass; or, (*b*) is capable of hardening greatly by sudden cooling; or, (*c*) is both so cast and so capable of hardening.

Steel Castings: Unforged and unrolled castings made of Bessemer, open-hearth, crucible or any other steel.

Washed metal: Cast iron from which most of the silicon and phosphor have been removed by the Bell-Krupp process without removing much of the carbon, so that it still contains enough carbon to be cast iron.

Weld iron: The same as wrought iron; obsolescent and needless.

White pig iron and white cast iron: Pig iron and cast iron in the fracture of which little or no graphite is visible, so that their fracture is silvery and white.

Wrought iron: Slag-bearing, malleable iron, which does not harden materially when suddenly cooled.

THE MAZZA SEPARATOR FOR GASES—THE HIGHEST TEMPERATURE EVER ATTAINED BY MAN

Robert Kennedy Duncan, in *Harper's Magazine*, October, 1906.

Professor Duncan, who occupies the chair of Industrial Chemistry in the University of Kansas, contributed to the October *Harper's* a readable and instructive article on "High Temperatures and Modern Industry." A review is given of the increase in knowledge made possible by each increase in temperature afforded by successive discoveries, taking the reader from the bushwood fire of the savage, through the "good beach cole" of the alchemist, to the fiery furnace of the electric arc. Speaking of the importance of the oxygen blast in obtaining high temperatures, he thus describes two ingenious methods for obtaining it:

"As everybody knows, placing the 'blower' on the grate increases the per cent of oxygen passing over the fuel in a given time; it is the principle of the forced draft. But enormously better results may be obtained in another way. Since combustion depends upon the twenty-one volumes of oxygen in the air, why not increase its per cent by abstracting the inert and diluting nitrogen? This is being done to-day in two distinct ways. The first depends upon the use of liquid air. The boiling point of its constituent nitrogen is above that of its oxygen, and hence as its evaporation proceeds it leaves a liquid continuously richer in oxygen. Not only so, but Pictet and others following him have devised a "separator," by which the evaporating gases separate, because of their different specific gravities, in such a way that nitrogen passes off through one tube and oxygen through another. This method is one of completely demonstrated efficiency; it is attracting wide attention in France, and it may safely be predicted that in a few years it will enormously increase the output of the unit blast-furnace and high-temperature steels.

"The other method is a most curious one, and depends upon the hitherto unsuspected fact that it is possible to use centrifugal force in order to separate out a mixture of gases. The idea that with a revolving wheel it is possible to whirl out of the air nitrogen to one corner and oxygen to another seems almost absurd, and yet it is apparently capable of practical application.

"The 'Mazza Separator,' as it is called, contains a centrifugal wheel, which, revolving in the air at speeds from 1,200 to 2,200 a minute, is capable of concentrating the per cent of oxygen at the periphery. According to the experiments of Professor Schaefer, of the Technical School at Charlottenburg, the apparatus increases the per cent of oxygen in the air drawn from the periphery from twenty-one volumes to twenty-six. Again, according to an Italian firm of papermakers, who applied the separator to air furnished to their Cornish boilers, they saved throughout a month's working no less than 27.7 per cent of their coal. Of course, it is capable, also, of whirling hydrogen out of illuminating gas, and so increasing its luminosity; of whirling carbonic acid out of waste blast-furnace gas, thus making it more available for the new blast-furnace engines; and, in fact, if its actual industrial practice yields even a modest approximation to the enormous claims of its manufacturers, its use ought to result in striking economics in furnace practice."

As to the furthest point yet reached in the direction of high temperature, the author says: "According to a paper recently communicated to the Royal Society, Sir Andrew Noble has reached the highest point of temperature in terrestrial thermometry. He has accomplished this by exploding cordite in closed vessels with a resulting pressure of fifty tons to the square inch, and a temperature of no less than 5,200 degrees C. Sir William Crookes saw that one incidental result of this experiment should have been the formation of diamond—that is, if his calculations were correct. On working over the residues of the explosion chamber he has recently extracted from them small crystals that seem to be veritable diamonds. We see, then, that if men cannot control the conditions that make for large diamonds, they, at least, understand them. It is, in all likelihood, a matter of a comparatively short time when the diamond will have been conquered as absolutely as the ruby.

"With this final temperature of 5,200 degrees C. we have reached the limit of man's present attainment. On looking back, we see that every step in temperature he has so far taken has led him just so far along the path to universal conquest—the absolute conquest which he is destined ultimately to make. But in this phase of temperature alone he has far to go. We have had evidence from many sources that even in the sun, which is by no means the hottest of the heavenly bodies, and which yet possesses temperatures that transcend anything we know on earth, the very elements of matter lie there disintegrated into simpler forms. Such temperatures are the distant Alpine heights ever and ever so far higher than the slight ascent to which we have so tediously arrived."

ALUNDUM—ITS MANUFACTURE, CHARACTERISTICS AND USE.

Abstract of a description prepared by the Norton Co. in response to numerous requests.

No more remarkable advance in mechanical lines has taken place in modern times than the development of grinding. The field of the old grindstone was limited, and the sharpening of edged tools was almost its only use. But the introduction of the emery wheel made grinding a very important operation. The emery wheel has not only rapidly replaced the grindstone, but in many operations the work of the cold-chisel, the lathe tool, the file, and other steel-cutting tools is now done more efficiently by grinding.

Before the invention of the electric furnace, artificial abrasives suitable for grinding wheels were unknown. Wheel manufacturers necessarily depended upon natural products—chiefly corundum and emery. As emery occurs in considerable quantities in various parts of the world, it came to be recognized and used as the chief raw material for grinding wheels and other products employed in grinding metals. On this account the modern grinding wheel made of any abrasive is popularly known as the "emery wheel."

The Norton Company has during the past few years been operating an electric furnace plant at Niagara Falls, New York, in which has been developed and brought out a superior abrasive, known as alundum, and which is conceded to be one of the important electrochemical products made possible by the Niagara Falls power development. Eleven electric furnaces have been installed there, each capable of turning out three tons of alundum every twenty-four hours.

The process of making alundum consists in taking the purest amorphous oxide of aluminum found in nature, known as the mineral bauxite, and purifying and melting it in the electric furnace in a large, homogeneous bath or fluid mass. Upon cooling, this molten fluid solidifies and crystallizes in solid masses of alundum of great purity and absolute uniformity throughout.

Bauxite, the raw material from which alundum is made, is the purest naturally occurring amorphous oxide of aluminum known. This mineral was originally found at Baux, France, from which it derives its name, but purer forms are now obtainable in the United States. The best quality only is used in the manufacture of alundum, and in its preparation practically all impurities are removed. The high grades of bauxite used are of rare occurrence. The Norton Company, however, owns its own mines from which the purest grade is obtained.

The bauxite is heated in large preliminary heating furnaces to drive off the combined water, and is then melted directly in electric furnaces of special design. Bauxite was considered infusible until the invention of this process, no heat of combustion being able to melt it, the electric arc only being equal to this task.

The temperature, at which the furnace charge melts in one homogeneous mass, is above the limit by which temperatures are measured by any means known to science, and is variously estimated between 6,000 and 7,000 degrees F. The operation of these furnaces and the composition of the molten bath is under the control of the furnace operative. Exact quality and uniformity, which is so important in steel manufacture, is fully as important in the manufacture of alundum. The highest grades of steel are now being made in electric furnaces similar in design to the alundum furnace, because impurities can be removed at the high temperatures obtained by the electric arc, and the quality of the molten bath uniformly maintained. In the alundum furnace both the purity and uniformity of the alundum is assured. Each step in the process is under the close supervision of expert chemists.

The large masses of molten bauxite are allowed to cool and crystallize in great ingots of purified crystalline alundum. Beautiful crystals are found in the center of these masses, showing nearly all the variety of colors found in the ruby and sapphire, of which alundum is the commercial, artificial product. The rarer colors of light pink, blue and purple found in the rarer oriental gems are sometimes noticed in small crystals. The ingots of alundum are broken up into small pieces by means of powerful crushers. It is then passed through series of rolls to reduce it to the various sizes of grain, which are finally separated by passing over sieves of different mesh to prepare it for manufacture into Norton grinding wheels, rubbing and sharpening stones, etc.

The solid massive alundum, while resembling the purest natural corundum in chemical composition, has the remarkable quality of being considerably harder than the natural product. This is due to the perfectly fluid condition in which the mass is melted, the control of its composition, the rate and method of its cooling and crystallization by which it receives its temper, the absence of water of combination (which almost invariably exists in natural corundum), and the pure and even state in which the fluid mass crystallizes.

The introduction of alundum in the field of grinding has been remarkably successful and rapid. The requisites sought for and attained in this abrasive are extreme hardness and sharpness, combined with uniformity and proper temper. These, alundum has in the highest degree.

To have sharpness in order to obtain the most satisfactory results—so far as rapid and continued cutting is concerned—a peculiar quality is necessary. There must be a fracture which will give a number of sharp-cutting points. This is obtained in alundum to better advantage than in any other abrasive material.

In the matter of hardness the recognized standard is the diamond, which is No. 10 in the scale of hardness; nothing that man has yet discovered or made equals the diamond in hardness. The term "hardness" is, therefore, a comparative term, the hardness of a mineral being ascertained by its ability to scratch another mineral of a known degree of hardness, or to be scratched by such a mineral.

Pure crystalline corundum, represented by the best sapphire or ruby, has always been the standard of No. 9 in the scale of hardness. This is readily scratched by alundum; in fact, alundum powder is used for cutting and drilling rubies and sapphires for watch jewels, etc.

After numerous careful tests, comparing alundum grains with other abrasive grains, including the diamond, alundum is found to exceed 9½ in the scale of hardness where the diamond is 10.

By "temper" is meant its strength of grain and the character of its fracture under grinding pressure. An alundum grain is remarkably tough and will stand more crushing pressure before breaking than any other abrasive grain, but when it does break down it breaks with a sharp, crisp fracture, giving a fresh, keen-cutting edge. This is a most important quality in an abrasive.

The purity and uniformity of alundum far surpasses that of any other abrasive. Purity, besides resulting in greater hardness and better temper, is necessary in the bonding of the grain into wheels, in order to secure accurate and uniform results, and uniformity is necessary to secure constant efficiency and accuracy of grade and temper in a wheel, so that wheels can be accurately duplicated at any time and maintain their standard of work.

Uniformity is one of the most important requisites in an abrasive. The ability to duplicate a grinding wheel is essential to efficient results from its use. In grinding wheels the abrasive grain of given size is bonded together to produce a certain grade or temper for a certain kind of work. This means that the bond, which holds the grains together, must be harder or softer according to the particular work required of the wheel. Different grades are required for different materials to be ground; cast iron, steel, brass, glass, bone, leather, wood and other substances demand wheels of special grade which must be duplicated to make the grinding operation continuously efficient. It is for this most important reason that great stress is placed on evenness in quality of the abrasive itself. Grades cannot be duplicated accurately without having a known and dependable factor in the uniformity of the material composing the wheel; and this important requisite is to the highest degree found in alundum.

Alundum and the process of making it were awarded the Grand Prize at the St. Louis Exposition. The individuals responsible for its invention and development were honored with diplomas and medals for their part in this most notable, practical invention.

APPRENTICESHIP IN THE UNITED STATES.

Abstract of Report of Apprenticeship Committee of the National Machine Tool Builders' Association, 1906.

At the fifth annual convention of the National Machine Tool Builders' Association at the Hotel Breslin, New York City, October 9, Mr. E. P. Bullard, Jr., presented the final report of the Apprenticeship Committee, which had been directed to make a thorough analysis of the systems now in use throughout the United States, and to make suggestions for the guidance of the association in taking such action as might be advisable in the direction of uniform apprenticeship requirements. The following paragraphs give an abstract of the essential features of the report.

A series of letters containing fourteen questions was addressed to 51 machine tool builders and 41 other manufacturing concerns employing machinists. Replies were received from 49 machine tool builders and 26 from concerns engaged in other lines. The following were the questions asked:

No. 1. Do you indenture apprentices to the machinist's trade?

No. 2. Have such apprentices proven satisfactory from a commercial standpoint?

No. 3. What is the approximate ratio between the number of apprentices and machinists employed?

No. 4. Have graduate apprentices of your works been advanced to positions of authority while in your employ?

No. 5. Is difficulty experienced in securing a sufficient number of intelligent apprentices?

No. 6. Are applicants required to have a specific amount of previous school training?

No. 7. Are courses of instruction provided for apprentices during their term of service?

No. 8. Is attendance on these courses compulsory?

No. 9. Are apprentices under the charge of a special instructor while employed in the works?

No. 10. Are apprentices permitted to work on either the premium or piece-work systems?

No. 11. Are small tools provided for their use free of charge?

No. 12. Are inducements of either shorter time or increased pay offered to technical graduates to learn the machinist's trade?

No. 13. Do you indenture apprentices to the various branches of the trade, such as lathe work, planer work, etc.?

No. 14. Is any provision made for these special apprentices to become regular apprentices, should they desire, after having completed their special apprenticeship?

The following synopsis, taken verbatim from the report, gives the results of this inquiry:

1. The majority of Machine Tool Builders have established apprenticeship systems, which are in more or less satisfactory operation. A smaller percentage of the allied trades have some system, but one large industry, the automobile manufacturers, with one exception, employs no apprentices.

2. Apprentices have proven satisfactory from a commercial standpoint.

3. The approximate ratio between the number of apprentices and journeymen employed by The Machine Tool Builders is about 18 per cent, whereas the allied trades do not average over 13 per cent.

4. Graduate apprentices have been advanced to positions of authority in many shops. Some concerns state that their foremen come almost entirely from this class.

5. All reports indicate that difficulty is experienced in securing a sufficient number of intelligent apprentices. It seems, however, that the question of wages and time of service have little effect on this question.

6. But few concerns require a specific amount of previous school training, the majority requiring a common school education only.

7. As a general rule courses of instruction are not provided for apprentices.

8. Those who do provide such a course make attendance compulsory.

9. Apprentices are usually under the direct charge of the foreman of the department.

10. About 50 per cent of the concerns employing apprentices permit them to work under either the premium or piece work systems.

11. Thirty-three per cent provide small tools free of charge.

12. Thirty-three per cent offer special inducements to technical graduates, but state that they find it difficult to secure them.

13. Twelve per cent state that apprentices are taken to the various branches of the machinist's trade.

14. But a small percentage of the above make provision for special apprentices to become regular apprentices after having completed their special course.

This problem then resolves itself into the following:

Having an insufficient number of skilled workmen, we can only increase this supply by teaching the machinist's trade to an increased number of boys. Finding difficulty in procuring a sufficient number of boys for this purpose, we must offer inducements which will attract them to the trade.

We would therefore suggest: First, the drafting of uniform apprenticeship contracts, covering both regular and special apprentices, same to be binding both to the employer and employee, the former to be obliged to properly instruct the latter in the branch or branches of the trade specified in the contract, and we suggest that the articles of indenture provide sufficient guarantee on the part of the apprentice for the satisfactory completion of his time of service, the wages paid to be optional with the individual employer. We believe this point is essential, as it is apparent from our investigation that apprentice wages vary in different sections of the country. It would seem advisable, however, to have a uniform term of service in all cases to be based on the time found necessary, by previous experience, to properly teach the branch or branches of the trade specified in the contract.

The number of apprentices employed in any shop should be limited only by the ability of the employer to properly instruct them.

Graduate apprentices should be advanced wherever possible, and preference given them in making promotions.

Special apprentices or those indentured to one branch of the trade only should have a common school education, and regular apprentices, or those indentured to the full trade, to have at least a grammar school education.

Courses of instruction for apprentices during their term of service should be provided, where practicable, and attendance upon such courses, where provided, be made compulsory. High school and technical graduates should be exempt from special study during their term of service. A special instructor should be provided where practicable.

Apprentices should be permitted to work on the premium or piece work systems. All small tools should be provided for their use free of charge, these to be furnished new on completion of their trial period, and presented to them on the satisfactory completion of their term of apprenticeship. These tools should be inspected by an authorized official at stated intervals and the condition reported. These reports would be valuable in determining the interest and ability of the apprentices.

Technical graduates should be encouraged to indenture themselves to the trade by offering higher wages and shorter period of service. Influence should be brought to bear upon those in authority at the technical schools to impress upon them the demand in the machine tool business for men having a technical education and willing to learn the practical side of the business.

Indenture apprentices to the various branches of the machinist's trade, making the term of service short and wages relatively high. Offer bonus or reward for the satisfactory completion of apprenticeship.

Offer an opportunity for special apprentices to become regular apprentices, should they so desire on the completion of their special apprenticeship, the time so served applying on the regular apprenticeship course in proportion as may be thought advisable.

Finally, issue a diploma, bearing the seal of the National Machine Tool Builders' Association, to both regular and special apprentices, stating clearly the work accomplished during term of service.

STRENGTH OF GEARS.

JOHN S. MYERS.

The best solution of the gear problem is by use of the "gear slide rule," an instrument somewhat resembling Sexton's Omnimeter in appearance, which was developed by Mr. Carl G. Barth and placed upon the market in 1902. This device takes into account all the variable factors involved in a manner not practical for any table or chart. The writer does not offer the present article, with the accompanying diagrams, as affording so speedy or easily attained a solution of the problem, but more as an introduction to the special subject of bevel gears; the method of treatment of this phase of the subject here given being original with Mr. Barth and not heretofore published. The formula used for varying the stress according to the velocity was also developed by Mr. Barth, but upon submitting it to Mr. Lewis, he found it to be identical with one the latter had developed, but, to the best of the writer's knowledge, had never published.

The Lewis formula and the factors of strength for gears were presented to the public in 1893, and have been quite generally accepted as the standard for computations. The stresses for different speeds as first recommended by Mr. Lewis were only given tentatively in the absence of sufficient data upon which to base a definite formula expressing a mathematical relation. They have been found to agree fairly well with good practice, which indicates that, taken as a whole, they were approximately correct, notwithstanding some marked irregularities which are clearly evident by an inspection of the accompanying diagram, (see Plate III in the Supplement) where the dotted line represents Lewis's original table of stresses for different velocities. The formula devised to supplant this original table is as follows:

Let V = velocity in feet per minute at the pitch line of the gear;

S_s = allowable static stress in pounds per sq. in., *i. e.*, the allowable stress when the velocity equals zero.

S_v = allowable stress at the velocity V;

$$\text{Then } S_v = S_s \frac{600}{600 + V}. \qquad (1)$$

This formula gives a logical basis upon which to vary the stress according to the velocity, the value of S_s being chosen to suit the material used, class of workmanship and condition of service. In the diagram the three curves are plotted for S_s = 4,000, 6,000 and 8,000 respectively when reading on the bottom scale designated stress for cast iron, or, when read on the top scale for steel, the corresponding values of S_s are 10,000, 15,000 and 20,000. In the chart for strength of spur gears (see Plate II in Supplement) the column on the left gives the working load for gears of 1-inch pitch and 1-inch face, the stresses used being as given by the 8,000, 20,000 curve, and the column on the right working loads for stresses according to the 6,000, 15,000 curve, the former being approximately the values as originally given by Lewis, which are intended for first-class workmanship, the latter being ¾ of these values and applicable to a rougher class of machinery.

In order to give the scale of this chart representing the number of teeth a uniform appearance it was necessary to smooth out the inaccuracies of the Lewis strength factors by plotting them to scale and drawing a curve through the general direction. The explanation given in connection with this curve (see Plate I in Supplement) is sufficient to elucidate the method pursued.

To use the chart for strength of spur gears:

Case 1. To find the strength of a given gear; follow the vertical line representing the number of teeth to its intersection with the oblique line of the proper speed, and from this point follow the horizontal line to the left and read off the working load for 1-inch pitch and 1-inch face. Multiply this by the product of the face and the circular pitch and the result is the working load for the given gear, if the workmanship is good and the service not severe. If the contrary is the case use the working loads in the column on the right.

Case II. To find the proper pitch and face of a gear to carry a given load; proceed as before, going to left or right according to workmanship and service, and divide the given load by the working load for 1-inch pitch and 1-inch face. Make the product of the circular pitch and face of the required gear equal to this quotient. When using diametral pitch reduce it to circular pitch by aid of the table given with the chart, the first decimal place of these equivalents being sufficiently accurate for the purpose.

Example of case II: What should be the pitch and face of a 15-tooth, cast iron pinion running at a velocity of 1,000 feet per minute and transmitting a working load of 650 pounds at the pitch line?

By the chart, in the column on the left, the working load for 1-inch pitch, 1-inch face is 225 pounds, then 650/225 = 2.89 = product of pitch and face for the required gear. One-inch pitch and 3-inch face would fulfill the conditions with a margin of safety.

Going now to the subject of bevel gears, Mr. Lewis gives the formula

$$W = SPFY \frac{D^3 - d^3}{3\,D^2\,(D - d)}, \qquad (2)$$

in which

W = working load reduced to the pitch diameter at the large end,

S = allowable stress at the given speed,

P = pitch of teeth at large diameter,

F = face of gear,

D = pitch diameter at large end,

d = pitch diameter at small end,

Y = strength factor depending upon shape of teeth and formative number of teeth, this formative number of teeth being equal to n sec $a = n \frac{L}{H}$, where n = actual number of teeth, a is the angle the pitch line makes with the center line, and L and H are the dimensions indicated in the sketch (see Plate IV in Supplement). He states that when d is not less than 2/3 D, as is the case in good practice, the formula

$$W = SPFY \frac{d}{D}, \qquad (3)$$

gives results almost identical.

If the above formulas be expressed in terms of the face F and the total possible length of face L they are then in a form which gives relative strengths for different face widths; and instead of expressing the limit of good practice in terms of the large and small diameters, which are only identical for both gears of the pair in the special case of miters, this limit is then stated by saying that the face width may be 1/3 L.

To express formula 2 in terms of F and L:

$D = 2\,L$ sin a and $d = 2(L - F)$sin a, then

$$\frac{D^3 - d^3}{3\,D^2\,(D - d)} = \frac{(2\,L \sin a)^3 - [2\,(L - F) \sin a]^3}{3\,(2\,L \sin a)^2\,[2\,L \sin a - 2\,(L - F) \sin a]}$$

$$= \frac{8\,(3\,L^2 F - 3\,L F^2 + F^3)}{24\,L^2\,F} = \frac{L^2 - LF + \frac{1}{3} F^2}{L^2} = \frac{L - F}{L} + \frac{1}{3}\left(\frac{F}{L}\right)^2 \qquad (4)$$

We may then write formula 2 thus:

$$W = SPFY \left[\frac{L - F}{L} + \frac{1}{3}\left(\frac{F}{L}\right)^2\right] \qquad (5)$$

The quantity in brackets is the ratio of the strength of a bevel gear to the strength of a spur gear of the same pitch and face. This quantity may also be written

$$1 - \frac{F}{L} + \frac{1}{3}\left(\frac{F}{L}\right)^2$$

Since $1/3(F/L)^2$ is small compared to $1 - F/L$ when F/L does not much exceed 1/3 it may be neglected and formula 5 then becomes

$$W = SPFY \frac{L - F}{L} \qquad (6)$$

which is accurate enough for all practical purposes. This is shown clearly in chart 1 (see Plate IV. in Supplement) where the full curved line, plotted from the calculated values given in the table just above the chart, represents the correct ratio of strength while the straight dotted line gives the approxi-

mate ratio $\frac{L-F}{L}$.

For $\frac{F}{L}=\frac{1}{3}$, the correct ratio $1-\frac{F}{L}+\frac{1}{3}\left(\frac{F}{L}\right)^2=1-\frac{1}{3}+\frac{1}{3}\times\frac{1}{6}=\frac{19}{27}=0.7037$ and the approximate ratio $\frac{L-F}{L}=1-\frac{F}{L}=1-\frac{1}{3}=\frac{2}{3}=0.6667$, which is a difference of only $\frac{1}{27}=0.037$, or less than 4 per cent error for the greatest face widths used in good practice and this error is on the side of safety.

Chart 2 shows the ratio of strength of a bevel gear of face F to the strength of a bevel gear of face L. It thus indicates the proportion of the total possible theoretical strength of the entire cone developed by any given face. The formula may be developed as follows:

$$\text{Ratio}=\frac{\text{strength of bevel gear of face } F}{\text{strength of bevel gear when } F=L}$$

$$=\frac{SPFY\left(\frac{L-F}{L}+\frac{1}{3}\frac{F^2}{L^2}\right)}{SPLY\left(\frac{L-L}{L}+\frac{1}{3}\frac{L^2}{L^2}\right)}=\frac{\frac{FL-F^2}{L}+\frac{1}{3}\frac{F^3}{L^2}}{\frac{1}{3}L}=3\frac{FL-F^2}{L^2}$$

$$+\frac{F^3}{L^3}=3\frac{F}{L}-3\left(\frac{F}{L}\right)^2+\left(\frac{F}{L}\right)^3 \qquad (7)$$

Values of this ratio, as given in the table above the chart, were calculated and used in plotting the curve. It is to be noticed that this curve commences to change direction rapidly from $F/L=0.3$ and over. When $F/L=1/3$ this theoretical ratio $=0.7037$ and in practice there has probably been developed 0.9 or even 0.95 of the possible strength to be attained. This is indicated by the dotted curve which shows clearly that there is nothing gained by making the face over about $1/3\,L$.

It is believed by the writer that this method of treating the bevel gear problem has much to recommend it and he therefore takes pleasure in presenting it to the readers of MACHINERY.

* * *

"WILL THE AUTOMOBILE FOLLOW THE BICYCLE?"

The following letters are replies received in answer to an editorial on the above subject which appeared in the October issue. They will be found of interest as indicating a conservative attitude of the leading automobile manufacturers to their business and their ideas as to its permanency. The future of the automobile and its economic effect are matters of importance to us all, whether we are users or non-users. Mechanical engineers, in general, are heartily interested in its ultimate triumph, for it is in direct line with general mechanical development, but many have become disgusted with the uses to which the automobile has been put by wealthy users. The influence of road races, cross-country runs and other manifestations of the sporting class have been of little good. It is probably safe to say that few, if any, of the automobile manufacturers are satisfied with the present trend of affairs. They build automobiles for pleasure and racing purposes because this at present represents the best market, but they all recognize the fact that the future of the automobile largely depends upon its value for strictly utilitarian purposes. As to the present status of the bicycle, it will be apparent that some of the writers do not agree with the common impression that the bicycle is out of date, but they rather imply that the number in use at the present time is more than ever before.

From E. R. Thomas Motor Co., Buffalo, N. Y.

"The rise and decline of the bicycle was a phenomenon well within the memory of most readers. Will the automobile follow the bicycle?"

As a manufacturer of bicycles, I confess that the sudden decline of the use of bicycles was a severe and unexpected shock, and its quickly waning popularity was without a parallel, except roller skating.

It was patent to every bicycle manufacturer that the abnormal demand for bicycles created by intense competition and the most strenuous advertising could not continue forever. As long as radical improvements were made each year, that contributed to ease of running, light weight and beauty, it was an incentive sufficient to induce a large majority of riders to change their mounts annually.

The decline was further accelerated by an overproduction of cheap—almost worthless—wheels, riders continuing the use of their bicycles for two or more years, instead of only one when great annual improvements were the rule; the increase of gear which made harder work, and strange to say, prices becoming too cheap, etc. But after all the so-called decline was the temporary lull from an abnormal to a normal demand. There are more bicycles manufactured in France, and possibly England, than ever before, and American bicycle manufacturers tell me that notwithstanding the wealthier classes have retired from the field in favor of automobiles, the demand is steadily increasing and the business is again on a profitable basis.

From another point of view, there is no parallel between the uses of bicycles and automobiles, and there is no reason why the decline or fall of one should influence the other.

The bicycle is primarily more an article of pleasure and relaxation than a necessity. It was never supposed to usurp the functions of a horse—its radius to the average rider was much more limited, it was rather dirty and required too much exertion to remain permanently popular with the wealthier classes, most of whom owned horses, carriages, etc. I never heard of anyone discarding horses and relying principally upon bicycles for their method of transportation, while most automobilists are discarding horses.

In my opinion, the question should properly be: Will the demand for automobiles have a decided lull and a slow reaction the same as the bicycle?"

To a comparatively limited extent, I should say there will be within a few years a temporary and healthy lull in the demand for pleasure cars. At the present time, there are a large number of automobile manufacturers who have neither the capital, experience, facilities or volume of business to profitably succeed, and that element will necessarily and gradually withdraw. The beginning of the end of that kind of competition has already begun, for more than fifty small or prospective manufacturers. As a matter of fact the small manufacturer cannot now successfully compete in price and quality, for the large manufacturer now makes and ships the first two hundred or more cars without profit.

Since ancient times, the only method by which individuals were transported, was the horse, and the use of the horse, both for pleasure and business, had constantly increased for two thousand years up to within the past two or three years, when the decline of the horse for the transportation of individuals has noticeably decreased each year more and more.

Baron Rothschild predicted four years ago that within ten years the horse would not be seen on the streets of Paris. Even a better authority has predicted that within two years not a single horse-drawn cab will be seen on the streets of Paris. The streets of Paris to-day are full of automobile cabs that transport individuals cheaper and faster than horse cabs, and the most skeptical observer must admit, upon investigation, that the automobile within five years will entirely succeed the horse in everything except freight handling, and even that day seems not to be far off.

If it is a fact that for two thousand years the horse was practically the only method by which individuals were transported with scarcely, if any, improvement, since the days of the Roman chariot, the automobile, being the only successor, must be the only method until some better way is devised. This, at the present time, is not even dreamed of or predicted, and hence, I believe that for a thousand years, the automobile, especially when changed, perfected and improved to suit the growing needs, will be practically the only method by which individuals are transported beyond a walking radius, and the demand will increase and increase until the man afoot, beyond a short walking radius, will be a rarity. In fact, it may not be an idle dream to predict that within a century the practice of walking long distances will be discontinued and people will be unable to take long walks, but will use roller skates, bicycles, motor bicycles and automobiles. E. R. THOMAS.

Buffalo, N. Y.

From Ford Motor Co., Detroit, Mich.

You make the erroneous statement that there are less bicycles in use to-day than in the days when they were the craze. I think if you will take the trouble to look it up you will find that there were more bicycles manufactured last year than there were manufactured in any one year previously. The Geo. N. Pierce Company, of Buffalo, who rank as one of the most successful automobile concerns, will tell you that their bicycle business is still the more profitable industry, employs more men, and is altogether of greater magnitude than their automobile business.

True, there are not so many concerns manufacturing bicycles as there were; but this is due to the fact that the bicycle has to-day been reduced to absolutely standard form and is

manufactured in enormous quantities by automatic machinery. It was only when this state of perfection had been reached that there was over-production of bicycles.

You say, "In many towns the bicycle is rarely seen on the streets." If you take another look, you will see them in plenty. The difference is that we do not *notice* them now days. It is true that as a pleasure conveyance the bicycle has out-run the craze period, but only a few days ago we had to build a large addition to our bicycle shed to take care of the new machines of our employees. In other words, it is a utility vehicle.

You will remember that you saw more automobiles on the streets when there were only a score or so of them than you do to-day when there are thousands. They were a curiosity then, now they are as common as horses.

We agree with you that the "cross-country runs," to express in your own very admirable terms, "tearing through the country at railroad speed, going nowhere in particular, and seeing nothing as he goes," will soon come to an end. I think the majority of automobilists, while demanding high speed possibilities in their machines, really prefer to drive at a rational pace and enjoy the fresh air and scenery, rather than gulp down dust and leave dust behind them for others to swallow; and for genuine pleasure riding the touring car will stay, while for business purposes the runabout will take the place of the horse-drawn runabout almost exclusively. Then in the commercial field the possibilities are simply unlimited.

Concluding, the bicycle is not past but still remains the most useful mode of transportation for the individual that man's ingenuity ever devised. There is no relation between the automobile and the bicycle, except the pneumatic tires, any more than there is between the horse and the bicycle; and there is no more reason why the motor-propelled vehicle should ever become obsolete than there is that we should substitute ox teams for locomotives for cross-country transportation.

E. Le Roy Pelletier.

Detroit, Mich.

From Olds Motor Works, Lansing, Mich.

Notwithstanding the fact that people are constantly predicting that the automobile is a fad, and will soon go the way of the bicycle, yet such is not the case. One might almost as well say that steam cars or electric cars will be relegated to museums in the course of a few years.

Any one who has studied the subject of transportation knows that anything which is done to decrease the time required for conveying people or freight from one place to another is bound to succeed and should realize that the automobile will fill its niche and remain an important factor in the business world. Whether or not the strictly pleasure vehicle will survive is a question.

Many of the men who are now driving machines are well-known horse fanciers, and it will not be at all strange if they take up this sport again after they are tired of motoring. A large number of automobile enthusiasts are in a like position, and may lose interest, but it is hardly possible that they will give up their machines entirely, owing to the fact that the new form of transportation has already become a necessity of their daily lives.

From a business standpoint, however, the situation looks entirely different. The various produce men of the country have already installed a large number of trucks and other style of motor cars; telephone, telegraph and railroad companies are using them in connection with their traffic department, and nearly all of the large wholesale and retail dealers in the cities have, or are contemplating the purchase of some sort of horseless vehicle. With the coming of good roads and good pavements the cost of transportation by means of the motor car will decrease proportionately, and the time will soon come when automobiles will no longer be a luxury but an absolute necessity—one of the most valuable adjuncts of the commercial world. Nor is this true alone of the larger companies. Individual salesmen, real estate agents, and in fact every business man who is called upon to make frequent and sometimes lengthy trips about the city, find a machine such an easy means of getting from place to place, that they would as soon think of giving it up as of throwing their telephone out of the window.

No; there is no question but what the automobile has come to stay and we, as manufacturers, are putting forth every effort to put this business on a strictly standard basis, and produce a car which will not be in style one year and out of style the next, but a machine which will be practically comfortable and serviceable for years to come.

Lansing, Mich. Fay L. Faurote.

From Stevens-Duryea Co., Chicopee Falls, Mass.

This is a subject in which we have been very much interested for a number of years, and, consequently, have looked it up much more carefully than people who are not directly interested in a heavy, financial way. Studying the situation of recreation and sports for many years past, we cannot help but notice that those sports which require a large expenditure of work by the participants, sooner or later lose some of their stronghold and, in that way, become "back-numbers."

Now every sane person knows that the recreation which one gets from a limited amount of bicycle-riding, golf or tennis playing, is a grand good thing for the human system; but in all of these sports a large amount of personal effort must be expended by the player, and many times in the year when the weather is very warm and uncomfortable, one prefers to sit on the piazza or in the shade of a good tree, rather than to go out in the open and exercise, which, if used in a limited quantity, would certainly do more good than inaction.

We consider that the human race is naturally lazy and one wants to get through life as easily as possible and with as little expenditure of energy as he can; consequently, the sports which give the most recreation with the least exertion would be the ones to stay with the public.

We consider that the automobile and the motor boat (and possibly in the near future, the balloon) will cover that requisite. Now take the motor boat business as an illustration: We consider that to the water what the automobile is to the land; but as the motor boat business has been developed many more years than the automobile industry, we have some data to work on in connection with the latter.

One cannot travel anywhere on the water nowadays without being surprised at the large number of motor boats of all sorts, shapes and sizes which are found throughout the country. The motor boat business has increased by leaps and bounds for a number of years past, and no man would think, in these days, of taking a twenty-mile pleasure row to call on a friend in an evening, when he could sit in his motor boat and be landed there with no energy on his part and a very pleasant recreation for both himself and his friends.

What applies to the motor boat business we think will equally apply to the automobile business, and, while the present prices of automobiles are prohibitory to a large class of people, yet in the future development, simplification of parts and stability of styles, makers not being obliged to change their entire output from year to year, will naturally bring about changes in prices, the same as it has in the motor boat business. The motor cycle is another illustration of an article which is becoming very popular from the fact that a person is able to cover a very large amount of ground without very much effort on his part.

When the "denaturized alcohol" bill goes into effect, it may reduce the cost of running both of automobiles and motor boats considerably, and, as time goes on, other materials may be adopted to be used for fuel, and, in that way, reduce the cost.

But turning to the automobile truck situation: We feel absolutely positive that both the small and the large trucks will very largely supersede horse-power for moving the traffic of our towns and cities. It may take quite a little while to bring this about, but it is surely coming as certain as the sun rises every morning. We do not consider that it is more than a few years away when every small tradesman who makes delivery of goods or parcels will have his automobile carriage or truck for delivering the same, taking the place of his horse-drawn vehicle.

J. H. Page.

Chicopee Falls, Mass.

* * *

One of the petty abuses to which the various express companies seem to be given is the deliberate losing of empty return packages for butter, eggs and other farm products. Finding that the return privilege means the annual handling of thousands of empty packages for which no direct return is obtained, the companies are apparently following the policy of side tracking such packages indefinitely and making the shippers stand the loss. It seems to be another example of the deliberate trampling on the rights of people who have to make use of the common carriers, and is one of the examples which tend to make people in general regard all transportation companies sourly and with suspicion. The abuse is one of considerable importance when we consider the enormous number of packages used annually for handling such products. With the present high price of lumber and the growing scarcity and consequent increase in price it becomes more and more imperative that economy in packages should be the rule. Years ago express companies made the concession of returning empty packages free in order to stimulate this class of shipments. The matter of negligence on the part of common carriers is held as not coming within the purview of the Interstate Commerce Committee, but seemingly it is an abuse which must be handled by a body more powerful than the private individual.

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The coming exposition of safety devices mentioned in the October issue will be held at the American Museum of Natural History, New York, January 28 to February 9, 1907. The exposition will show safety devices for protecting the lives of workmen and of the general public; it will also have exhibits pertaining to industrial hygiene, care of the health, etc.

A EUROPEAN MACHINERY HOUSE.

In the attractive city of Cologne, founded more than a thousand years ago on the banks of the Rhine, the writer found the most complete establishment for selling machine tools in Europe or America; the center of a wonderful selling organization which covers a great part of Europe and is now reaching out for trade in the Orient. The foundation of the business of Alfred H. Schütte was laid twenty-six years ago, and with its branches now employs a staff of commercial men and engineers numbering about three hundred. The main offices and salesrooms at Cologne cover a floor space of 40,000 square feet, and including the branches at Brussels, Liege, Paris, Milan, Turin, Barcelona and Bilboa, the firm will have

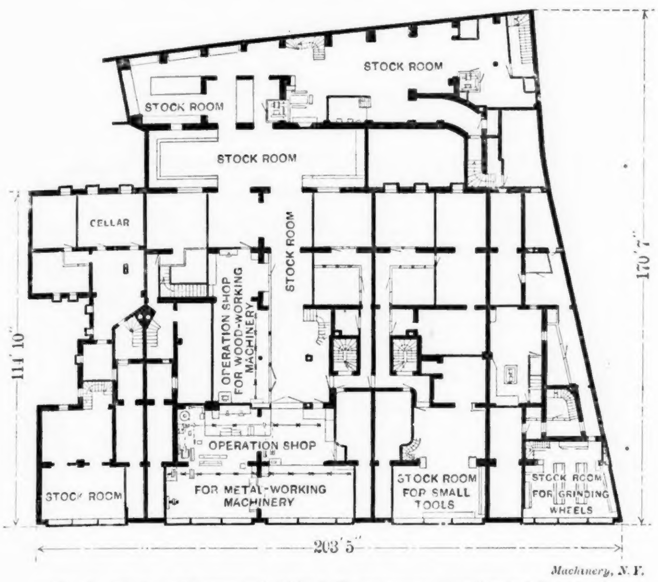


Fig. 1. Plan of Basement, Alfred H. Schutte's Machinery Store at Cologne, Germany.

a floor space of nearly 120,000 square feet after January 1st next, when the new stores under construction at Paris and Milan will be occupied.

The salesrooms at Cologne face one of the large squares in the center of the city, and have a row of show windows 205 feet in length in the handsome building which we illustrate, and which has been especially designed for the use of this firm. These windows permit not only a view of the salesrooms, but of a considerable part of the basement near the street, where metal and woodworking machines of the latest type are being operated under power, and where a plant of pneumatic tools is also shown in operation. The demonstration of machines in operation is found in nearly all of Mr. Schütte's stores and contributes largely to the success of the firm, because European engineers are more likely than our own to insist on seeing a machine in operation before purchasing. These facilities enable the firm to educate their staff of salesmen in the systematic manner characteristic of German methods, and they also contribute to the education of the young mechanical students of Cologne and vicinity.

The arrangement of the small tool department shown in one of the views is both attractive and convenient. Heavy oak is used for the wood work, and all the small tools, such as twist drills, reamers, etc., of which they carry a large stock, are placed behind sliding plate glass windows. One of the salesrooms is used exclusively for the exhibition of grinding wheels, and the writer saw there the largest stock that he had seen anywhere. The showrooms are situated on the ground floor and the operating rooms in the basement, which not only affords excellent light on the machines, but adds a touch of life to the building as the machines are seen in operation through the basement windows, a feature which is seldom found in a machinery salesroom. Facing the square are the private offices with bookkeeping and statistical departments. In the latter department each customer has an account showing the inquiries he made with the results of the offers submitted to him and his purchases, which affords an opportunity for calling the salesmen's attention to customers whose purchases have dropped off in any particular line.

An interesting feature is what might be termed the daily inventory. Every day a list is prepared showing a summarized statement of all the machines in stock in each of the stores of Alfred H. Schütte throughout Europe. At night all the machines sold during the day are checked off from this list and a new one prepared, a copy of which is furnished the next morning to every man who has anything to do with inquiries for machinery or tools. This list enables him to find at a glance whether a certain machine is in stock or not, without going into the stock rooms and referring in each particular case to the keeper of the stock. This feature of the system actually amounts to a daily inventory, but on account of the precision with which the records are kept there is very little delay or unnecessary work connected with the making up of these lists.

The department for correspondence, etc., is located in the rear, and its organization is very thorough and carried out in great detail. There are four different departments having charge of the sale of different kinds of machines and tools, each of which has special engineers at its disposal to push the selling end from both the mechanical and engineering points of view. Statements of sales are made up by every department at the week's end, and naturally each one tries to outdo the other in this friendly competition. In the department which handles automatic machinery is an unusually complete collection of sample pieces that have been made on full and half automatics sold by the firm, with full information regarding the cost of output, material, time required, etc.

One feature which indicates the extent to which the details of organization are carried is worth noting: Each Monday Mr. Schütte has on his desk a brief summary of every letter of importance that has been received or written by all of his houses throughout Europe and the answer thereto, as well as a complete statement of all machines and tools sold and in stock in each branch house during the previous week. These are arranged in the form of a list, and if Mr. Schütte for any reason, desires to follow up the details further he simply marks with a blue pencil the specific letters

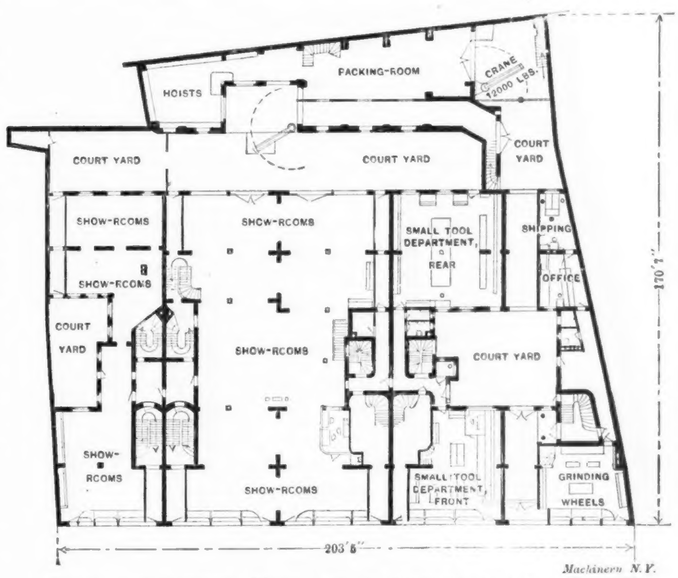
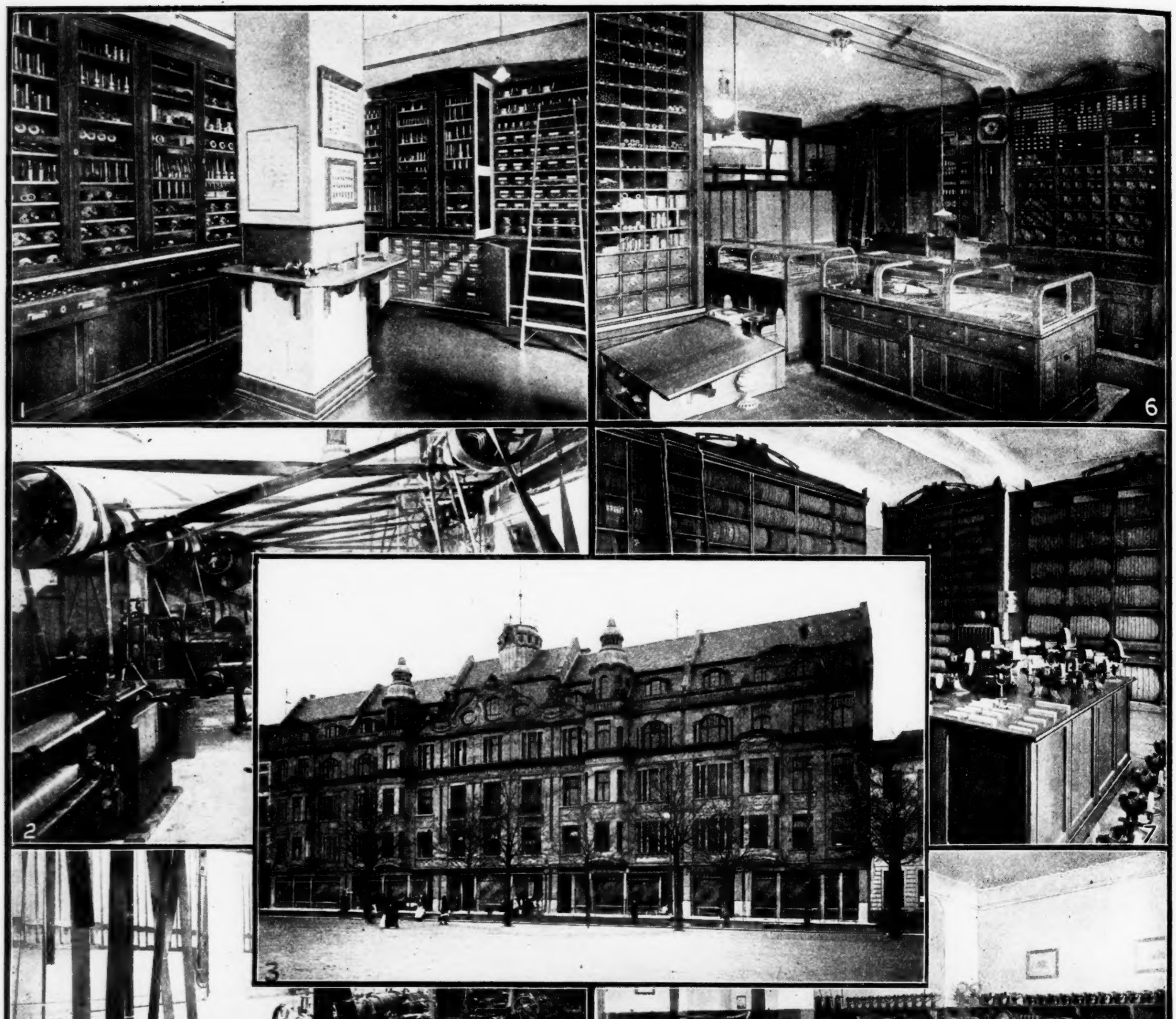


Fig. 2. Plan of Ground Floor, Alfred H. Schutte's Machinery Store at Cologne, Germany.

he desires, and complete copies are brought to him. All that portion of Europe covered by the Schütte organization is regularly visited by a large staff of salesmen reporting to the headquarters for each territory. In this way the entire territory is covered, not only by salesmen, but by specialists connected with important manufacturers whose product the firm sells. The catalogue and advertising work is in charge of engineers with practical experience in those lines.

Separated from the main office, but adjoining Mr. Schütte's private office are the offices of the newly established Asiatic and South American export department, in charge of Mr. T. H. Marburg, who until recently was manager of the New York office, and at the time of the writer's visit was preparing for a trip around the world to cover two years, for the



1. Special Tool Department for Automatic Screw Machines.
2. Testing Room for Woodworking Machinery.
3. View from Street of Alfred H. Schutte's Machinery Store, Cologne, Germany.
4. Testing Room for Automatic Machinery.
5. Main Machinery Hall, Right Aisle.
6. Small Tool Department, Front.
7. Grinding Wheel Store, seen from the Left.
8. Grinding Machine Store.
9. Main Machinery Hall, Left Aisle.

purpose of forming new connections and cultivating existing ones.

The organization of the different branches is carried along on similar lines, and a short description of these will doubtless be of interest.

In the small but wealthy industrial country of Belgium the firm employs a staff of thirty-four men. In 1897 a branch was started at Brussels under the management of Mr. A. Ispert, who is a junior partner of the Belgium firm. The gradual increase of business soon made it necessary to abandon the original quarters for larger ones at 5 Vieux-Marche-aux-Grains. In 1903 a sub-branch was established at Liege, the center of the Belgium arms manufacture, and in this branch the firm is doing a good business in small tools. A demonstration room has recently been erected in the rear of the Brussels store in order to improve the existing facilities for showing tools in operation, and including this new addition the firm has now over 12,000 square feet of floor space in the busiest parts of Brussels and Liege at its disposal.

The French establishment of the firm was organized in August, 1903, under the management of Mr. Max Bühling, and although only entering its fourth year is one of the largest dealers in American machine tools in France. The present offices are located near the center of Paris, but owing to the development of business a new building specially adapted to machine tools is now under construction and will be finished by the end of the year. This store will be about four times the size of the present one, covering a floor space of about

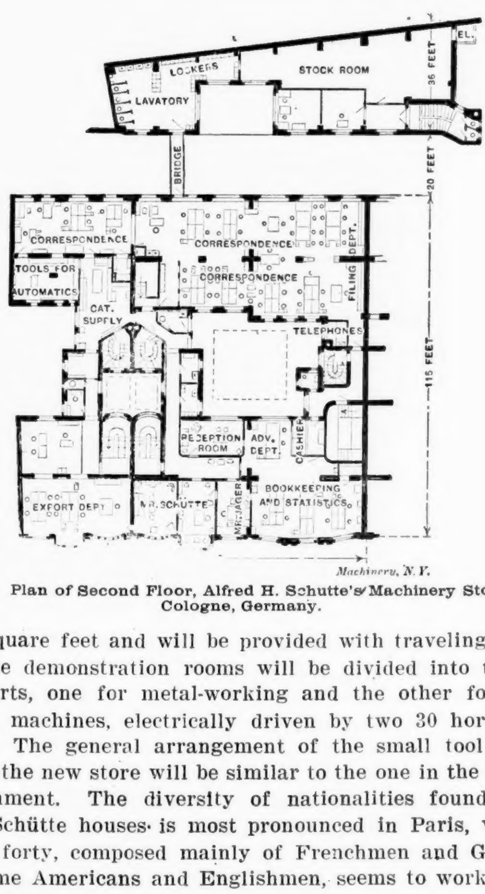


Fig. 3. Plan of Second Floor, Alfred H. Schutte's Machinery Store at Cologne, Germany.

25,000 square feet and will be provided with traveling cranes, etc. The demonstration rooms will be divided into two distinct parts, one for metal-working and the other for wood-working machines, electrically driven by two 30 horsepower motors. The general arrangement of the small tool department at the new store will be similar to the one in the Cologne establishment. The diversity of nationalities found in all of the Schütte houses is most pronounced in Paris, where a staff of forty, composed mainly of Frenchmen and Germans, with some Americans and Englishmen, seems to work in perfect harmony.

The Italian branch was established in Milan in April, 1903, under the management of Mr. H. Wingen, who had previously worked up a connection among the leading Italian manufacturers, notably those in the motor car industry, which has since then developed with great rapidity. The Milan branch was started with twelve employees, but during the past three and a half years the business has increased to such an extent that a force of about sixty is now employed, and a store established at Turin to further facilitate the distribution of goods, as well as a branch office at Genoa to handle machinery arriving from America. New quarters somewhat similar to those in Paris are under construction, which will give the Milan branch a floor space of about 25,000 square feet after January 1, 1907.

Business in Spain has been pushed by the firm for many years, but not until 1903 was a store opened at Bilboa and put in charge of Mr. Max Daunert, formerly manager of the New York office. The machinery industries are developing slowly in Spain, manufacturers there not taking as readily to the better class of tools as in other European countries. Notwithstanding these conditions and the general depression which has prevailed in Spain for the last two years, the firm has started a second store, also under Mr. Daunert's management at Barcelona, and the prospects are good for satisfactory business.

At New York the firm maintains an office in the Havemeyer Building, 26 Cortlandt Street, Mr. F. W. Jaeger, manager, which keeps in close touch with the machinery trade in this country and cares for the shipments to the different branches.

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ANNUAL MEETING OF THE A. S. M. E.

The annual meeting of the American Society of Mechanical Engineers will be held in the auditorium of the New York Edison Co., 44 West 27th Street, beginning December 4, and continuing through December 7. Following are the papers:

President's address by Mr. Fred. W. Taylor, Philadelphia, Pa.: "The Art of Cutting Metals."

Report of the Committee on Standard Proportions for Machine Screws.

"The Evolution of Gas Power," by Mr. F. E. Junge, Berlin, Germany.

"Producer Gas Power Plant," by Mr. J. R. Bibbins, Pittsburg, Pa.

"Steam Turbine Characteristics," by Mr. Hans Holzwarth, Hamilton, Ohio.

"A High Duty Air Compressor," by Prof. O. P. Hood, Houghton, Mich.

"Design of an Improved Boiler Setting," by Mr. A. Bement, Chicago, Ill.

"The Steam Plant of the White Motor Car," by Prof. R. C. Carpenter, Ithaca, N. Y.

"Saw-Tooth Roof Construction," by Mr. F. S. Hinds, Boston, Mass.

"Ferroinclave Roof Construction" by Mr. A. E. Brown, Cleveland, Ohio.

"Saw-Tooth Roofs for Factories," by Mr. K. C. Richmond, Providence, R. I.

"Weights and Measures," by Mr. Henry R. Towne, New York.

"Mechanical Engineering Index," by Prof. W. W. Bird and Prof. A. L. Smith, Worcester, Mass.

"Ventilation of Boston Subway," by Mr. H. A. Carson, Boston, Mass.

"Flow of Fluids in Venturi Tubes," by Mr. E. P. Coleman, Buffalo, N. Y.

"Tests of an Elevator Plant," by Mr. A. J. Herschmann, New York.

"Test of a Rotary Pump," by Prof. W. B. Gregory, New Orleans, La.

"Improved Transmission Dynamometer," by Mr. W. F. Durand, Stanford University, Cal.

"A Plan to Provide Skilled Workmen," by Mr. M. W. Alexander, Lynn, Mass.

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The ease with which some inventors are able to induce people of sufficient capital to believe in the possibilities of their inventions has often been referred to. However, our English brethren seem in this respect to excel our own inventors. An English gentleman who lately attended the London Bankruptcy Court and whose liabilities amounted to $75,000, compared with $7,500 assets, stated that his financial difficulties were due to his connection with an inventor who invited him to join in a hydroscope scheme. The hydroscope, he informed the court, was an instrument for searching under the sea for sunken treasures and he was to be reimbursed either from the treasure when discovered, or out of the proceeds to be derived from the sale of the patent to an exploiting company. It is at least to the credit of our English contemporaries that the forming of such a company did not seem to be within the possibilities of the able inventor. We find occasion to recall the incident of the American company which a few years ago was to proceed to procure gold out of sea water.

WILLIAM KENT.

REPRESENTATIVE AMERICAN MECHANICS AND ENGINEERS.

William Kent was born in Philadelphia, March 5, 1851. He was educated in the public schools and graduated from the Central High School of Philadelphia in 1868 with the degree of A.B. The degree of A.M. was conferred in 1873. He was clerk and bookkeeper in a coal shipping house for nearly two years and then was bookkeeper in the Jersey City gas office two and a half years. While there he attended night school in Cooper Union, New York, and graduated with the class of 1872. After graduation he obtained the position of bookkeeper in the Ringwood Iron Works, at Hewitt, N. J., where he had an opportunity to get some practice in engineering and chemistry. The depression in the iron trade following the panic of 1873 caused the shutting down of the blast furnace, and he left at the end of 1874 to enter Stevens Institute of Technology as special student. In June, 1875, he was appointed assistant to Prof. R. H. Thurston in the work of the United States Iron and Steel Testing Board, and under his direction carried on for two years a research on the properties of the alloys of copper and tin, and copper and zinc. He also qualified as regular student in the senior class and graduated in 1876 with the degree of M.E.

In 1877, on the conclusion of the research, he went to Pittsburg to take a position as draftsman with a firm of blast furnace engineers. While in that position he made a trip through the new iron district in the Hocking Valley, Ohio, and wrote an account of the district for the *American Manufacturer* of Pittsburg. This led to his appointment as editor of that paper, which position he held for two years. In the next three years he was engaged in the iron and steel works of Shoenberger & Co., first as general assistant, and later as superintendent of the open hearth steel department. A severe attack of typhoid fever followed by a nervous breakdown led to his resigning his position in 1882 and going to Europe for three months for his health. On his return he opened an office in Pittsburg for the Babcock & Wilcox Co., and introduced that company's boilers in Western Pennsylvania and Eastern Ohio. He also formed a partnership with William F. Zimmerman in the organization of the Pittsburg Testing Laboratory, which was sold three years later to Messrs. Hunt and Clapp. In 1883 he was transferred to the New York office of the Babcock & Wilcox Co. as superintendent of the sales department and engineer of tests. He resigned in 1885 to become the general manager of the Springer Torsion Balance Co. He developed the invention of the balance (a weighing scale with torsional pivots instead of knife edges, used generally in the retail drug trade), and built and equipped a factory in Jersey City for its manufacture. This work occupied him until 1890, when he opened an office in New York as consulting engineer.

For the next thirteen years his work was of the most varied character, including engineering design and construction, engine and boiler testing, expert work in the courts, and literary work. In 1891 he began work on his "Mechanical Engineer's Pocket-Book," which took four years to complete. The book was published in 1895 and immediately was recognized as filling a long-felt want among engineers, draftsmen, machinists and others having to do with mechanical work and design. More than 45,000 copies have been sold at the present time and the sales are increasing from year to year. Prof. Kent is an ardent opponent of the metric system and in speaking against it before the House Coinage Committee of Congress in 1903 he used his experience in the compilation of the pocketbook against the adoption of the metric system in the following effective language (see MACHINERY, May, 1904):

"In 1895 I published a mechanical engineer's pocketbook, of which more than 30,000 copies have been sold. The collection of material for this pocketbook took more or less of my time for twenty years, and the making of the book not less than three years' full time. The things compiled in it involved reference to engineering works, papers and periodicals, some of them dating back at least sixty years. There are 1,100 pages in the book, and each page has about 900 words. The number of figures and formulas in the book, which are based on the English inch, run into more thousands than I would care to figure. The task of getting such a book free from errors is a tremendous one. Over a thousand typographical and other errors have been reported in the last eight years. Mr. John C. Trautwine, Jr., told me some twenty years after his father's civil engineers' pocketbook was first published that he was only then beginning to feel that the book was reasonably free from errors. If my book were translated into the metric system, it would be at least ten years before all the errors in the translation would be rectified. I doubt if the translation could be made without at least five years' hard labor of an expert mathematician."

In 1898 and 1901 he obtained patents on the "Wingwall" smokeless furnace for steam boilers, which is now being introduced in the West by his agents, Power Specialty Co., New York and Chicago. He also patented in 1903 a gas producer for use in connection with gas engines. It involves the principle of getting rid of the tar in the gas by burning all the hydrocarbons in the producer itself by means of air drawn in at the top of the producer. In 1901 he brought out his treatise on "Steam Boiler Economy." In 1895 he became one of the associate editors of *Engineering News*, holding the position until 1903, but in the last four years of that time did only occasional editorial work, on account of the pressure of other work. In 1903 he accepted the position of Dean and Professor of Mechanical Engineering in the L. C. Smith College of Applied Science in Syracuse University, which position he still holds. In 1905 the university conferred on him the degree of Doctor of Science.

Prof. Kent has been a member of the American Institute of Mining Engineers since 1876, and of the American Society of Mechanical Engineers since its organization in 1880. He has been vice-president of that society and last year he was president of the American Society of Heating and Ventilating Engineers and of the Technology Club of Syracuse, N. Y.

* * *

Two large chimneys of reinforced concrete are at present being built in England, one with a diameter of 20 feet and a height of 265 feet, and one with a diameter of only 8 feet 6 inches and a height of 245 feet. In this country there are also a few chimneys of similar proportions being built out of reinforced concrete. There are ample indications that concrete is going to replace brick in a large measure in the future, particularly with present high prices of brick. Certain kinds of brick have doubled in price during the last decade.

* * *

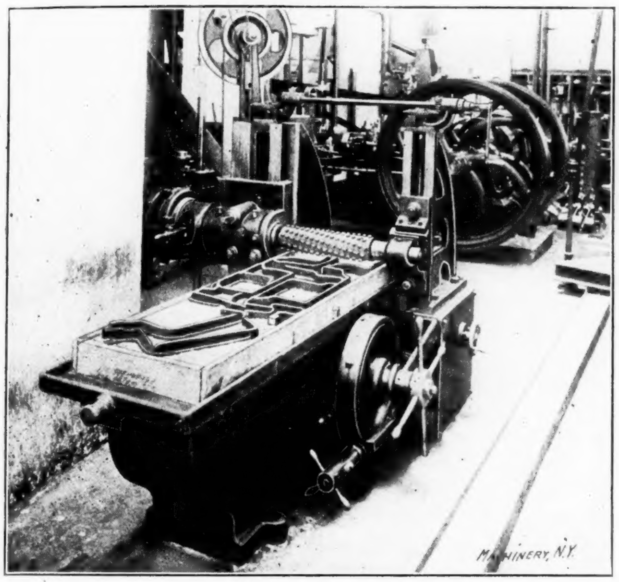
The possibilities which will present themselves in many fields where denatured alcohol can be used are fairly indicated by the low price at which it can be sold when produced on a sufficiently large scale. The present wholesale prices in Germany, where more than 25,000,000 gallons are consumed in a year, are at present 25 to 26 cents a gallon, and the retail prices vary from 27 to 30 cents a gallon.

LETTERS UPON PRACTICAL SUBJECTS.

HOLDING THIN IRREGULAR CASTINGS TO THE PLANER TABLE.

We have seen in your September issue an article "Planing a Small Machine Part." The examples given are very good indeed, but we think that we have something fully as interesting on the same line to put before your readers. The chucks and jigs shown in the article are very expensive; they take up considerable space and in our opinion they do not quite fill the purpose, especially when the castings are very thin. The accompanying halftone shows how we hold thin, irregular castings on the table of the planer or the milling machine. The idea has been carried out by our works manager, Monsieur Tête, and is a development in the manufacture of our pattern plates.

The illustration shows a number of irregular-shaped castings on the table of an Ingersoll milling machine, which we have in our works. When the castings are in place, four boards or planks are put on the four sides of the table and a few pieces of wood in the table holes. Then plaster-of-paris is poured around the castings and allowed to set for a few minutes. By this means the pieces are not only clamped but supported underneath the whole surface, and thus have no



Holding Thin Irregular Castings to the Planer Table.

tendency to spring under the pressure of the cutter. This method when first tried proved a success and since this time all work of a similar character is made in the same way in our works. The method saves a lot of time and is a real economy in the cost of production. We believe that the idea can be extended a great deal and that it will be of benefit to some of your readers. Plaster-of-paris is very cheap and sets in a few minutes. The only drawback to its use is that the table of the machine gets dirty after the plaster has been broken into pieces.

PH. BONVILLAIN AND E. RONCERAY.

Paris, France.

FINISHING VALVE SEATS AND CYLINDERS.

There are probably more differences of opinion regarding the proper way to finish valve seats for slide valves in locomotives and boring cylinders than in regard to almost any other parts of the whole locomotive. In most cases the valve seats are planed and scraped and the valves treated in the same way. Scraping seats to a bearing means a lot of work, and unless it is done by a good man it is apt to be worse than when it came off the planer.

Wilson Eddy, whose genius presided over the old Worcester and Springfield road in the late fifties and sixties, and who was a wonderfully sensible railroad man in many ways, used a false valve seat of cast iron about as shown in Fig. 1, and held the whole thing down by the steam chest cover, which was bolted on the outside, as shown by the stud holes. The false seat was more necessary in the days before the portable planer than now, and it was not of this as much as of his way of finishing that I intended to speak. The valve was clamped to the planer with as little strain as possible, to avoid spring when released, and after the roughing cut (if a new valve), the finishing cut was made with a sharp pointed V tool with a fine feed, so as to make a series of fine grooves along the face of valve. The seat was planed in the same way, but with the grooves running the other way, and they

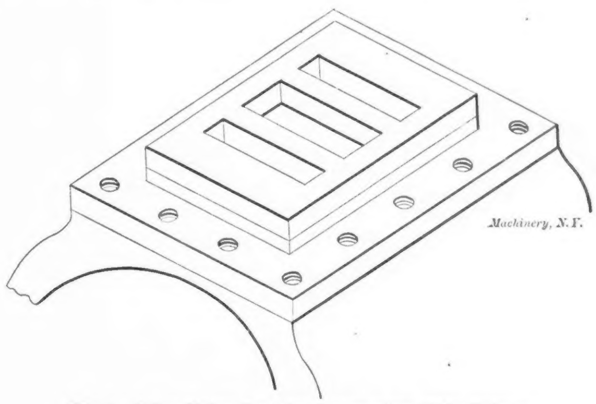


Fig. 1. False Valve Seat for Locomotive Slide Valves.

went into service without having a scraper touching the seat or valve. The grooves held the oil until the tool marks wore out, which happened in a comparatively few miles and the valves never cut. They wore down to a bearing, and made a first-class job in every way. Even with the seats planed by a rotary planer as at present, there should be no trouble about using valves planed in this way and it would at least be worth a trial. Fig. 2 gives an exaggerated idea of the tool marks left on the face of the valve; those in the seat run the other way.

Cylinder boring is another question that is open to discussion. It used to be considered a crime to stop a lathe or boring mill on a cylinder cut until it was through, and some places even go so far as to use emery in the cylinder to polish them and get out the tool marks. I believe the emery is bad in any case and I also question the advisability of trying to get such a smooth cylinder. One of the best engineers I know of, one who has charge of large steam plants and is responsible for their economical performance, never allows a finishing cut to be taken in the cylinders of his engines, either when making them new or when reboring. He prefers to have them just as they come from the roughing tool. They soon wear down to a good bearing, the piston travels too fast to have any leakage past the rings around the bore of the cylinder, and he can always depend on what a cylinder will do in the way of tending to business and not get to cutting. Last but not least, it saves the cost of the finishing cut as well as the time it keeps a locomotive out of service, and this time is quite an item when slowly-working portable boring bars are used so as to facilitate the work. Whether you try the plans or not they are worth thinking over.

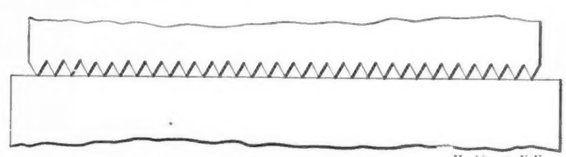


Fig. 2. Exaggerated Appearance of Valve Face.

I. B. RICH.

JACK MAKES A FORMULA.

We were making some rings at our shop, of a section shown in Fig. 1. The fillet was made up of two curves; one had a short radius s and was ⅝ inch long, while the other radius R had its center 1½ inch from the vertical side, but the length of R was figured out so that we should have a smooth curve

when the two arcs met. Of course the fillet was a tangent to the vertical and horizontal sides.

There were several sizes of rings and we were to make templets for them; so while I was making the first drawing our apprentice, who is just now having a show at drawing, took a sketch of the ring and fillet, and tried to hitch up his correspondence school mathematics to the job of pulling out a formula to give the exact length of R. Jack had to have a little help to get started and then it was just like other algebra examples in his book.

His sketch is shown in Fig. 2, and all the dimensions are letters instead of figures:

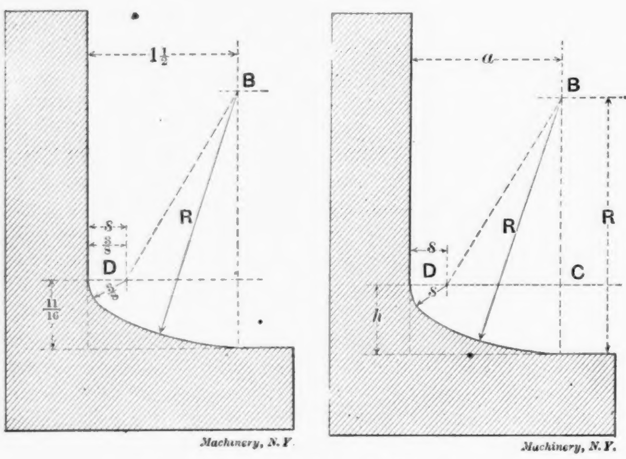
a = distance from vertical wall to center B.
s = distance from vertical wall to center D.
h = distance up from horizontal wall to center D.
R = distance up from horizontal wall to center B.

We know all of these distances except R (see Fig. 2), and if we can make up an equation using these distances we can solve the equation and find the length of R.

Suppose we let R swing up to the line $B\,D$ and at the same time let s swing down till its arc meets the arc made by R. These curves will meet and make a smooth curve for the fillet. Jack says he can prove that by geometry. There is a triangle, $B\,C\,D$ in Fig. 2, with a right angle at C, and we can make up an equation by the aid of this right-angled triangle.

The side $B\,C$ is equal to $R - h$;
The side $C\,D$ is equal to $a - s$;
The side $D\,B$ is equal to $R - s$,

because R and s make a straight line from B through D to the fillet. Now, in every triangle like $B\,C\,D$ the square of the side opposite the right angle is equal to the sum of the squares of the other two sides. Hence Jack wrote his equation as follows:



Figs. 1 and 2. Jack Makes a Formula.

$$(R - s)^2 = (a - s)^2 + (R - h)^2$$

and solved for R as below:

$$R^2 - 2\,R\,s + s^2 = a^2 - 2\,a\,s + s^2 + R^2 - 2\,R\,h + h^2$$
$$R^2 - R^2 + s^2 - s^2 - 2\,R\,s + 2\,R\,h = h^2 + a^2 - 2\,a\,s$$
$$R\,(2\,h - 2\,s) = h^2 + a^2 - 2\,a\,s\,.$$
$$R = \frac{h^2 + a^2 - 2\,a\,s}{2\,h - 2\,s}$$
$$R = \frac{h^2 + (a - 2\,s)\,a}{2\,(h - s)}$$

Jack substituted the dimensions given in Fig. 1 ($a = 1\frac{1}{2}$, or 1.5 inch; h = 11-16, or 0.687 inch; $s = \frac{3}{8}$, or 0.375 inch) in the formula and multiplied, added, etc., as the signs in the formula direct.

$$R = \frac{0.687^2 + (1.5 - 0.75)\ 1.5}{2\ (0.687 - 0.375)}$$
$$R = \frac{0.472 + 1.125}{0.624}$$
$$R = \frac{1.597}{0.624} = 2.559, \text{ or } 2\ 9\text{-}16 \text{ inches, very nearly.}$$

Then I set my compasses to Jack's figures and finished the fillet. It was all right. The templet maker has not yet found any trouble with the radius, and Jack is sure the radius R is all right.

If the boys in the shop would try to figure out some problems that come up there, they would get the knack of applying their mathematics to "cold iron." The above has been written to help young men like Jack to use some of the mathematics they have studied.

JACK'S FRIEND.

THE BORING BAR VS. THE FORGED BORING TOOL.

There is scarcely any machine shop operation more tedious and unsatisfactory than that of boring a *long* hole, which is required to be *quite parallel*, with a common forged boring tool. In the best manufacturing shops, suitable drills and reamers are provided for each job, and standard sizes are

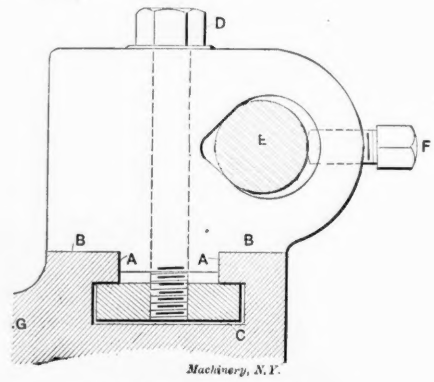


Fig. 1. Boring Tool Holder.

generally used. But in the repair shop and job shop the conditions are quite different. In the very nature of the case such shops cannot have tools exactly suited to every unexpected and nondescriptive job which may be presented. However, some job shops make very little effort to keep up with the times, and their equipment is too much of the scrap-heap order. The writer at this time has in mind one of these back-number institutions. A short time ago Mr. A. brought to the shop in question a job of boring which was wanted in a hurry. Well, he did not get it in a hurry; and when the bill was presented the charges were so much beyond what Mr. A. had expected that he consulted the writer as to how it was possible to put in so much time on the work. The latter consisted in enlarging the bore of a device which was sold on a very small margin. When the job shop got the work done there was no margin at all. Now, there had apparently been no dishonesty as to the time charged. It was difficult to true up the work in the "rickety" old chuck, and it took a long

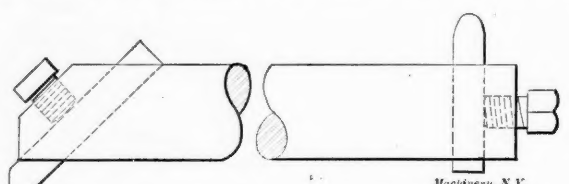


Fig. 2. Boring Bar with Cutters Inserted.

time to bore it, because the only long tool available was by far too slender and "springy." Mr. A paid the bill, but declared he would never take another job to that shop. The job shop man presumably means to be honest, but the writer fails to see how one can be strictly conscientious who *regularly* uses time-wasting tools and charges the full price for the time so wasted. However, the job shop proprietor did not see the matter in that light.

There have been various designs of boring tool holders described in the mechanical papers. The best of these require a different bushing for each size of bar; but such as have been made by the writer need no bushings. Fig. 1 shows an end view of a device which costs very little to make, and which works very well. This was designed for a young machinist who has a small shop with no other machine tools than a lathe

and a drill press; and he wanted to avoid the expense of having his casting planed, or of milling it at a disadvantage in his lathe. Under these circumstances the pattern, which was in one piece without core prints, was made so close to size that it required but a few minutes chipping and filing on the sides *A* of the tongue, and on the flats *B*, to make the casting fit the slot of the tool rest *G*. The part *C* in the sketch was simply a piece of flat bar stock equal in length to the slot, and tapped for two screws *D*. The bar, a section of which is shown at *E*, is held by two setscrews *F* as indicated. As to the construction of the bars, these were also made, or at least could have been made, with small expense. While a turned tool steel bar might be desirable, simple cold-rolled steel, or rough machine steel will answer fairly well. The cutters may be round bar steel (no turning is needed) held in a drilled hole by set screws. Fig. 2 shows such a bar with a cutter at each end. Three or four different sizes of these bars will answer for a wide range of work. Now, is there any excuse for the job shop being without such an outfit as this? In the long run, far more time is wasted in using inefficient boring tools, and in redressing old ones, than would be required to make the tools here described.

Having tools somewhat similar to the foregoing, the writer once wanted to bore a hole which was too long for any bar on hand. It was a simple matter to select from the stock of steel the shortest piece of the right diameter, and drill it for cutters and set screws. This was accomplished in less time than would have been required to forge a new tool. As the bar was only about three feet long it was retained for emergencies; but obviously it could have been cut up and used for any other purpose. This case suggests the expediency of making the bars amply long in the first place. A long bar does not need to project from the clamping fixture any further than necessary for the job on hand. Not so with the old-fashioned boring tool. If that be made extra long it cannot advantageously be used with shorter projection.

One of the strongest points in favor of the boring tools here advocated is yet to be discussed. This feature can best be described by referring again to the foregoing example in which the long bar was employed. In this case a long parallel hole of a size different from any available reamer was wanted. Having rough bored the hole to within about 1-64 inch of the final diameter, a double-pointed cutter was made from bar stock. With this, one cut was taken through the hole, when it was found to be entirely satisfactory. It will be understood that the advantage of the double-ended cutter lies in the support that one point furnishes for the opposite cutting point. This bracing effect tends toward parallelism of the cut, and such an arrangement may take the place of a reamer in emergencies. To get the best results with a double cutter, its ends should be turned in the lathe while the cutter is secured in its bar. For this purpose one end of the bar may be held in a chuck, the other end being supported in a steady-rest placed near the cutter. After being turned, the cutter is, of course, backed off and tempered. In this connection it should be remembered that a minimum of clearance should be filed on the heel of the cutter, otherwise chattering will result. The apparatus described (cutters excepted) may be used for polishing a bored hole, or for slightly enlarging it at any point where the gage may fit a little too snugly. For this work secure a short leather sleeve around the bar at one end, and glue emery cloth to the leather. The bar while clamped in the fixture may be fed through the hole by the regular carriage feed mechanism. Slightly revolving the bar will give new contact of the emery cloth.

The machinist for whom the fixture shown in Fig. 1 was designed requested the writer to show him how to make a rig for grinding in the lathe. For this purpose a cylindrical piece of cast iron was drilled lengthwise and babbitted to fit a small emery-wheel spindle. The cast iron was then turned on the outside to slip in the boring fixture; and thus the latter was used both for holding boring bars and for holding the bearing for the emery-wheel spindle. This rig, which was driven from an overhead drum, answered for grinding the 60-degree centers (the compound rest being swiveled for this) as well as for parallel shafts. W. S. Leonard.

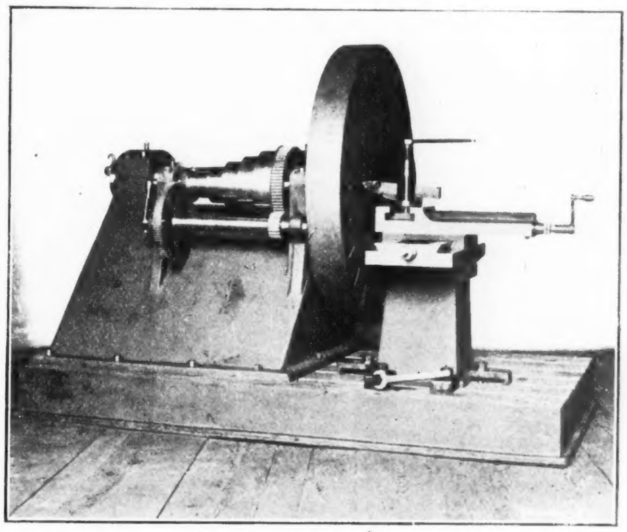
Lansing, Mich.

FACING LATHE OF UNUSUAL DESIGN.

The accompanying cut shows a machine, only one of which has ever been built so far as the writer knows, but the principle of which could be used for many special needs. It was built for work of from, say, 20 inches to 60 inches diameter to be fastened to the faceplate. It has feeds in all directions by means of an overhead rocking shaft, not shown. A hook will be noticed at the left-hand end of the spindle. This swivels on a bolt which can be moved across the spindle on a plate on the end of the spindle with a T-slot. To this hook is attached a chain which leads to one arm of the overhead rocking shaft and gives it a greater or less motion, according to the distance of the hook from the center line of the spindle. Near the other end of the rocking shaft is an adjustable arm which carries a chain which leads to a ratchet wrench which could be put either on the cross feed or the longitudinal feed-screw. With two holes in the ratchet lever, and the adjustment on the end of the spindle any feed from one tooth to five, or a range of from 0.02 inch to 0.1 inch could be obtained.

The way in which we happened to get the order for this machine was rather odd. One day an inquiry came from one of the numerous export agents in New York for a facing lathe to swing 50 inches, bid to be accompanied by drawings.

This inquiry came from a house which, so far as we knew, did not make a specialty of machine tools, and from such houses freak inquiries are common. I wrote and quoted on



Facing Lathe of Unusual Design.

a full lathe with short bed. We received a letter back saying that price was what counted, and that only certain requirements were to be met, and asking for a revision of the bid. The idea came to me that we could build such a machine as shown in the cut. Consequently I made a bond-paper drawing fairly well to scale, but with only the principal dimensions of the bed and headstocks, and by that time I was tired of the job. I had not the slightest suspicion that an order would result, so I cut out a picture of a tool rest for a locomotive tire turning lathe from a catalogue and pinned it to a blueprint of the bed and head, added a hundred dollars to what I thought would be a fair price, and sent in the bid without a further thought. Three or four months later I was astounded to get an order as "per blueprint and specifications" for one of these machines to go to Vladivostock, Siberia. I chased up the drawing which I found I had used to scribble on, cleaned it up, put on a few more dimensions, and started in to see how we could get out of making a full set of patterns. We made a frame for the base with the molding around the bottom and let the foundry strike off the inside. Then we took core boxes that were used to take out the inside of a radial drill base and spliced up the sides two inches to fit. These cores hung over the edges of the drag and formed core and cope as well. The head itself was hastily framed up of ⅞-inch material to form its own core. The boxes for the main spindle were cast for babbitt. The bearings in front were set up for an 18-inch head cone and back gears. The spindle was of cast iron, 9 inches diameter front bearing. To

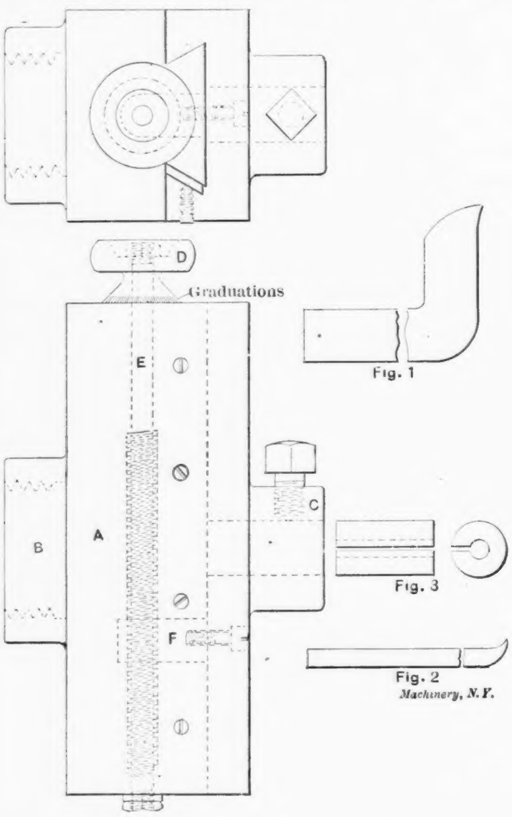
the spindle was keyed a 36-inch lathe faceplate with internal gear, but the faceplate was made 50 inches in diameter by casting on a false rim. This was swept up in the sand, and tightened by overhanging cores which framed both core and cope again. The spindle which ran through the cone pulley carried a driving pinion of steel to mesh with a cut internal gear on the faceplate. The tool rest demanded all new patterns except the top slide, which we took from a 36-inch lathe. The machine when ready proved to be just about what was wanted. It "growled" a good deal on high speeds, but on the size work called for it ran quiet enough. Except for the ratchet feed seeming a little crude, it was the equal, for work within its range, of the lathe on which we first quoted at a price three times as high, but with less than twice the profit in it for us.

E. H. Fish.

Worcester, Mass.

BORING TOOL-HOLDER FOR MILLING MACHINE OR LATHE.

The sketch shows a fixture to be screwed onto the spindle of a milling machine or lathe for boring holes in work fastened to the milling machine table or to the carriage or cross-slide of a lathe. For boring holes in jigs and fixtures where the holes have to be exactly certain distances apart, either



Adjustable Boring Tool-holder.

in a vertical or horizontal plane, the fixture, if used on the milling machine, is a very serviceable tool. The fixture is screwed onto the machine spindle at *B* and when a tool is clamped in the tool-holder, *C*, the fixture is ready for use.

The knurled knob *D* turns the screw *E*, which works in the nut *F*, and causes the tool to move to bore a hole larger, or to be drawn back for a smaller hole.

In case of wanting to use the fixture on a machine which has a different thread on the spindle than the fixture, a taper plug can be made which fits the taper hole in the spindle and is threaded on the other end to fit the thread in the fixture. This particular fixture can be used for holes from ¼ inch diameter up to 6 or 8 inches diameter and 6 or 8 inches deep. For large holes, the tool is made of stock the size of the hole in *C*, and for small holes the tool can be made of smaller stock, and a split bushing made to fit the hole in *C* on the outside diameter, and the hole in the bushing to fit the tool. For large holes, the tool should be bent to a right angle, so that the tool-holder *C* will not have to be adjusted too far out. The adjusting knob *D* should be graduated in thousandths inch as shown in the sketch to provide for accurate adjustment of the tool. The fixture is fitted with gib and screws for the tool slide.

To get holes bored accurately certain distances apart in the milling machine, the holes are first drilled with a smaller sized drill than the finished size, and then the boring tool is used in the fixture, feeding the table along according to the graduated collar on the feed screw. The holes can then be bored very accurately. The roughing drill can be held in a split bushing, fitting the hole in the fixture. This fixture is used in the tool department of the Cadillac Motor Car Co.

Referring to the sketch, Fig. 1 is a heavy tool for large holes, Fig. 2 is a tool for small holes, and Fig. 3 is the bushing for the small tool.

C. J. S.

TIME SAVING IN THE DRAFTING ROOM.

Under this heading in the August issue of MACHINERY Mr. F. R. Steuart recommends for quick duplicating of sketches a tracing in soft lead pencil. I believe my method is better than his, as it does away with any kind of tracing, pen or pencil, for sketches or for drawings. I have made short cuts and labor-saving dodges a close study for years, for the draftsman's work often comes in on the feast-or-famine plan, and there are times when a great volume of work must be rushed through quickly and accurately, though not necessarily with much neatness or finish. With the exception of drawings that must be repeatedly and frequently blueprinted, I make no tracings. Such as I make are made largely for the reason that they blueprint more rapidly and wear better. If the original drawing were used to blueprint from too often it would soon become worn out and unfit to make another copy from without much labor. So, for standard erecting plans, etc., I make tracings on cloth and keep the original carefully, though in the course of years it is likely to need alterations.

I use a smooth and semi-transparent drawing paper from which I can get a first-class blueprint in about two and one-fourth times the number of minutes required for tracing on cloth. The drawing is laid out in pencil, then the useless lines wiped off with a piece of "artgum," which is about halfway between stale bread and velvet rubber in its cleansing properties. It leaves the surface in good shape for inking, and when the drawing is inked it is done. There is no tracing to be made.

For sketching, I have two methods of duplicating, and which one is used depends generally upon the number of duplicates required. In case but one or two are needed, I make the sketch on fairly heavy cross-section paper with "Mephisto" colored copying pencils. The original sketch goes into the shop in this case, after being copied in an ordinary letter book with moistened pads. A second copy can be made on a loose sheet to send off in a letter if needed, but in case a second shop drawing is likely to be needed later I use the other method. This consists of a sketch made on thin cross-section paper with a stylographic pen loaded with Higgins' Eternal ink. This ink has sufficient body to yield a fair blueprint, though it is not thick enough to clog the stylo. If a more elaborate thing is required than a rough free-hand sketch, I lay it off in pencil and then go over the straight lines with the stylo, and the circles and arcs with the regular bow-pen or compass, which is much easier than trying to follow a true curved line with the stylo held in the hand.

From these stylo sketches a very good blueprint can be made, and working drawings put in shape for the shop in a very short time. The sketches are filed in indexed envelopes, and the copybook sketches in colored pencil are all indexed in the back of the book, so in either case it is not much of a job to locate an old sketch.

While I believe in making drawings and sketches fairly complete as to minor details, at the same time I think a liberal use of the English language legibly written on the same sheet with the sketch goes a long way to prevent misunderstandings. If draftsmen themselves cannot all agree as to what a certain view of a drawing really represents (and such cases have been spoken of more or less in the technical papers) is it any wonder the man in the shop sometimes has to scratch his head more than twice to see things as the

draftsman wants him to? Of course a written direction can sometimes be read differently by two men, each giving it a meaning of his own, but if the sentences are clear and concise, as all technical writing should be, there is not much chance for trouble here.

I believe in using just as many short cuts in the drafting room, and in the machine shop, too, as is consistent with good work and freedom from misunderstanding and mistakes. The drafting room is a mighty poor place to save time in when the saving is done at the expense of clearness and certainty, but as it is results that count, and not methods alone, any short cut that eliminates what is actually useless work should be given a fair trial. It may work in some cases and not in others, for the different classes of work, workmen, and shops must be taken into account. There are few good things that are of universal application, and drafting room practice must be, in a degree at least, adapted to the particular needs of the case in hand. In some shops it might be best to show each and every detail of a piece on the sketch and do away with all written explanations and additions, but I find written notes very helpful in most cases.

Drafting, like mathematics, is only a means to an end, and a man who makes his drawings as if they were the goal instead of a part of the course is likely to put a pile of work into them which is really useless. The sun may always shine from the upper left-hand corner at the Patent Office, and shade lines are well worth all the extra time they take on a good many jobs, but a fair amount of common sense is better than too many rules and regulations in a drafting room as well as outside of it.

E. R. Plaisted.

Montpelier, Vt.

OLD EUCLID IS ALL RIGHT.

In regard to the article "Old Euclid Disproved at Last" published in the November issue allow me to say that the drawing is distorted. With the angle ABD as nearly 90 degrees as it is shown, the perpendicular HG would be so nearly parallel with EF that the intersection of the two would be removed nearly at an infinite distance. Line BD if produced would then intersect EF long before HG reached it. Therefore the triangle DBK is impossible. Old Euclid is perfectly able to take care of himself even if he has been dead so many many years, but it is a good catch all the same.

Buffalo, N. Y. Geo. B. Snow.

OLD EUCLID DEFENDED.

In the November issue of Machinery "R. S." gives a remarkable proof (?) that Euclid made a mistake. In a case of this kind I think it is as bad to make a misleading drawing as to make a misleading statement. R. S. proved (?) that although the sides of one triangle are each equal to each of the sides of another triangle the angles were not of neces-

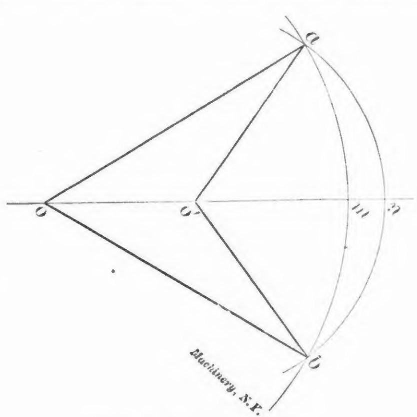


Fig. 1. Old Euclid Defended

sity equal. If his figure had been drawn correctly K would have been far enough away that DK would fall outside of point B. The above letters refer to his figure.

In Fig. 1 let amb and anb be the arcs of circles with centers at o and o'. From the definition of a circle o and o' must be equidistant from the points a and b. It is then easily proved that o and o' lie on the bisecting line of the angle $ao'b$ and aob, which statement must be true of any two arcs of circles intersecting in two points.

In Fig. 2 draw EE' (indefinite length) and AEB and $LE'C$ so that EE' is the perpendicular bisector of AEB and $LE'C$. Draw $BD = LB = AC$ so that angle DBA is larger than a right angle. Draw DC and erect a perpendicular at middle point H. EE' and HK intersect at K.

$CK = LK$, and $DK = CK$, as any point on a perpendicular bisector of a line is equidistant from the extremities; then

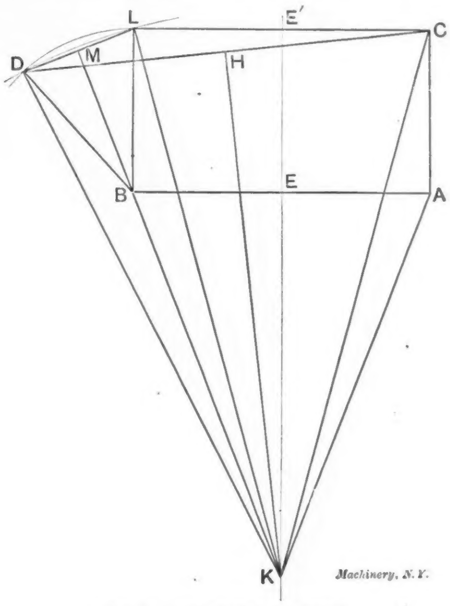


Fig. 2. Old Euclid Defended.

$DK = LK$ and an arc can be drawn through L and D with K as a center and also an arc through either L and D with B as a center. According to our proof in Fig. 1, B and K then lie on the line bisecting the angles DBL and DKL. It is then evident that the line combining D and K falls outside of the point B considered in relation to point A and the whole proof in the "R. S." article becomes a nonentity. If this is not enough to convince "R. S.," who seems to be an extraordinary individual, the proof can be elaborated still further. The proposition reminds me of one I saw some time ago where a square 8 inches on a side was so cut and pieced together that it appeared to be 5 x 13 inches or one square inch larger than the square 8 x 8. Of course on close examination the fallacy of this was very apparent.

O. R. McB.

[Communications from readers upholding Old Euclid have also been received from E. A. Johnson, Hartford, Conn.; F. W. Barrows, Bridgeport, Conn.; C. J. Stuart, Montreal, Canada; W. L. Miller, Wellsville, Ohio; Arthur C. Garrecht, Easton, Pa.; Robert Cramer, St. Louis, Mo.; A. F. Sharp, Williamsport, Pa, and G. F. Key, Alpena, Mich. Their rigid stand on the question will undoubtedly convince "R. S." that there is no hope for the Nobel prize this year.—Editor.]

A MACHINIST'S CHRISTMAS PRESENT.

No matter whether we are running but a lathe or a whole shop, the question of Christmas presents presents itself to us with clock-like regularity. The great question of what to give *him* or *her* is before us. One might think that a machinist of all people concerned must buy his presents already made up, *i. e.*, that he cannot make anything worth while in the gift line. This is of course a great mistake, as any machinist who is good with the file can fashion watch charms galore, in different patterns from an anvil to a miniature locomotive. These would of course only apply to Harry and Fred, but if Eva is introduced, the patterns must be enlarged to the paper weight size. A very nice pin can be made by drilling and filing out the metal between the rim and head in a dime, leaving enough at top and bottom to hold it securely, then get some plating company to gold plate either the rim or the head (not both) for twenty-five cents, and add a safety pin to the back, completing as pretty a pin as any girl could wish for if the work has been carefully done. Of

course needle files are required to get into small corners. The operation might be reversed, and the head filed completely out, covering the back with a thin sheet of gold metal, which would make a very odd pin. Personally I prize a gift which has occupied the time and thought of the donor much above the "boughten" kind, and I feel sure that others share this feeling. W. L. McL.

AN OLD PLANER.

The accompanying halftone is made from a photograph of an old planer which is still capable of turning out a certain class of work, not requiring any great degree of accuracy. This latter statement is not to be wondered at when we consider that for over twenty years it has been in the great outdoor world beside the shop from which it receives its power. The bed of this planer is 45 feet long and it enjoys the distinction of having two tables, which can be used either singly or together, two in one as it were. The two bolts for coupling the tables can be seen in the picture projecting from the end of one table; the camera is on the other, the end of which is shown in the foreground. At one time the machine could boast of two heads, the connections for which can be seen at the right of the cross rail, but doubtless one of the operators wearied of thawing out any more parts than necessary to get the planer going after a snow storm and threw it off. The maker of this machine does not have to explain to a prospective purchaser that it is "full geared," a glance to the left between the pulleys and table will convince one of this fact.

An Old Planer.

The machine was built in England many years ago, and while being lowered into the vessel's hold for transportation had a foot knocked off. When it arrived here the buyer refused to take it, and told the steamship company to either get it fixed or give him the price of the machine. Not knowing what an easy matter the repair was, they quietly handed over the full price, and charged no freight upon delivering it to him, thus the lucky gentleman got it for the cost of the repair which would be dear at ten dollars. Should anyone coming around that shop inquire as to "what *it* is doing out there?" he will be at once enlightened by one of the boys, "Oh we keep that for planing up the weather." NERALCM.

THE VALUE OF PROPER HARDENING.

The more I see of shop practice, the more I am convinced that few of us appreciate the value of properly hardened steel for tools and other purposes. My first recollections of early hardening operations show a small portable forge in which the fire pot was so small that air blasts must have hit the steel half the time and been responsible for many of the cracks that seemed mysterious at the time. Then too, I recall the warping of reamers and similar work, which had to be ground after hardening; taps that came out of the hardening water with numerous teeth missing, and milling cutters which looked as though a cyclone had struck them.

From what I now know, I believe most of these trials and tribulations could have been prevented if I had known of Mr. Markham's method of pack hardening. It is needless to say many dollars would have been saved my employer. Nor is this all; we are looking for steel that can cut 1,187 feet (more or less) a minute on rough work, but we lose sight of the fact that much of our work does not come under this head. This includes milling cutters both rotary and hollow, taps and dies and similar tools. They may come out of the bath whole and in good condition, but their cutting capacity is often below par. This may mean that a thousand-dollar milling machine is turning out a third less work than it should, and that it must be stopped entirely too often for grinding the cutters. This is by no means an exaggerated case, as there are numerous instances where a steel expert has greatly increased the amount of work by a proper hardening of the tools, and this with the same steel as before, or in some cases even a cheaper grade. Data on the subject of tool and cutting speed, that is, data which can be used as a guide in the average shop, is decidedly scarce.

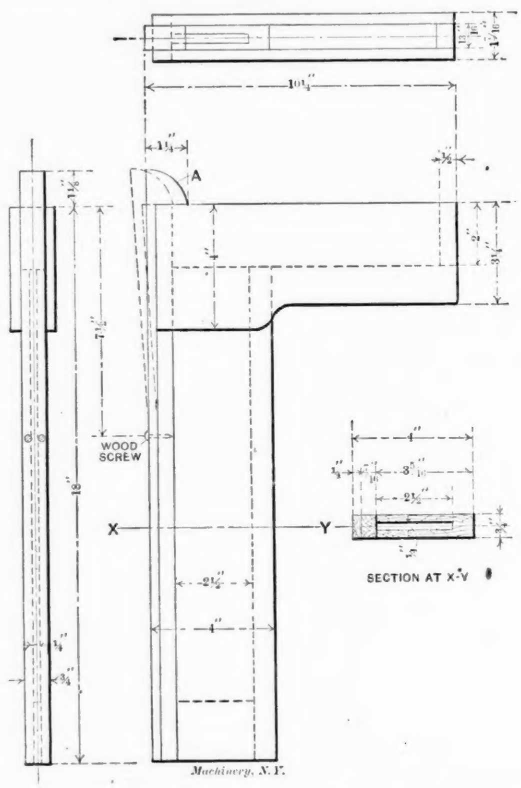
Some shops try to raise the speed themselves until the maximum is reached, which means that some cutters must be tested to destruction. In any large or even moderate-sized shop, it would probably pay to pick out a bright hardener and make it his duty to try to improve the working capacity of the tools. It does not pay to let a high-priced machine jog along all on account of a tool not worth over one per cent as much.

Then there is another side. It is the hardening, or perhaps, only casehardening of thin pieces which must be straight and true. If they warp, it's either a case of throwing away or spending time and money in straightening. Either way it is a loss which can be avoided if we just know how, and when we know that it is possible to prevent it, the sooner we do it the better. FRED H. COLVIN.

New York.

CASE FOR HOLDING AND PROTECTING LARGE SQUARES.

The accompanying cut shows a neat case for holding and protecting large squares when they are not in use in the machine shop. Machinists who have worked in various shops in the country claim it to be the best square case they have



Case for Holding and Protecting Large Squares.

seen. In the shop the case gets rough usage, but I have never heard of the latch permitting the square to fall out. The latch *A* is sprung back with the fingers when placing the square in or removing it from the case. The dotted lines

show the latch sprung back. All parts are firmly glued and the latch is fastened at a point about 7½ inches from the top with two small wood screws, preventing the same from being pulled off when it is sprung back. E. C. F.

BALL AND ROLLER BEARINGS.

George Le Guern.

The accompanying chart shows the result of experiments made in recent years by different firms on ball and roller bearings, from which experiments I have worked out the formulas and drawn curves. These formulas and curves are made for "safe working loads" for one ball and roller, which I think is the simplest and most practical way for the use of engineers and draftsmen. The matter is self-explanatory except it may be in regard to "three points ball bearings" where I have drawn the line MN parallel to line CAB, which not only assures a perfect radial contact between the three points, but prevents the balls from running over the lower path and does away with sliding between the top of the ball and the path.

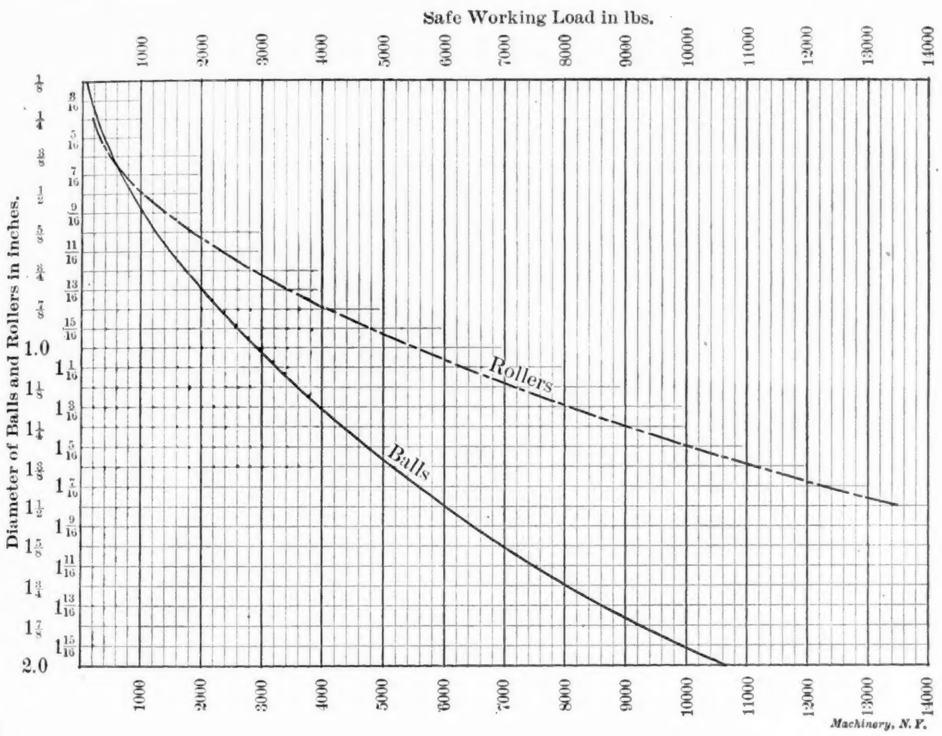


Fig. 1. Chart giving Safe Working Load in Pounds for Single Ball and Roller.

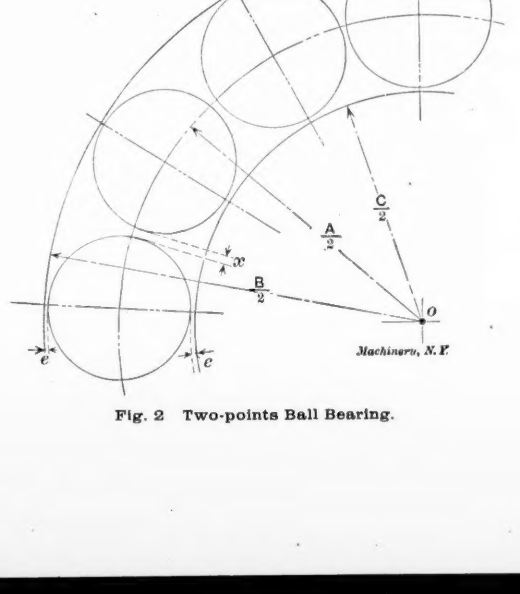


Fig. 2 Two-points Ball Bearing.

Formulas for ball bearing:

$D =$ diameter of ball
$N =$ number of balls.

Safe working load $= (D \times 10)^2 \times 31$

for balls up to 1 inch diameter, and

Safe working load $= (D \times 10)^2 \times 26.5$

for balls from 1 inch to 2 inches diameter.

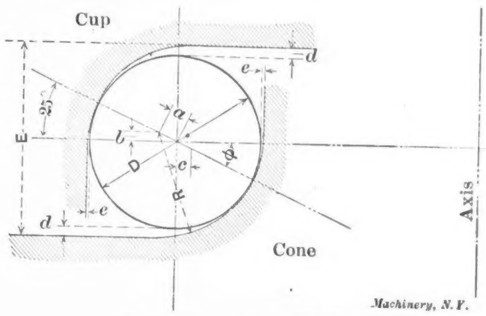


Fig 3. Two-points Ball Bearing.

Two points ball bearings: (Figs. 2 and 3.)

$x =$ clearance $= 0.003$
$a = 0.03125$
$b = a \sin 25° = 0.0132$
$c = a \cos 25° = 0.0283$

$$d = R - \frac{D}{2} - b = 0.018$$

$$e = R - \left(\frac{D}{2} + c\right) = 0.0029$$

$$A = \frac{D + x}{\sin \frac{180°}{N}}$$

$$B = A + D + 2e$$
$$C = A - (D + 2e)$$
$$E = D + 2d$$
$$R = \frac{D}{2} + 0.03125$$

Angle ϕ is figured at 25 degrees, which is good for general use. Where there is a great end thrust, angle ϕ is best made 30 to 45 degrees.

Three-points ball bearing: (Fig. 4.)

Make MN parallel to CAB.

Four-points roller bearing:

The upper part must be made same as the lower parts.

Formula for roller bearing:

Safe working load

$= [(D + k) \times 10]^2 \times 14$

where $D =$ diam. of roller in inches,

$k =$ term of an arithmetical progression, beginning at 0.1 for a roller ¼-inch diameter and having 0.075 for a common difference, when the diameters of the rollers increase by 1-16 inch. Values of coefficient k for a number of diameters are as follows:

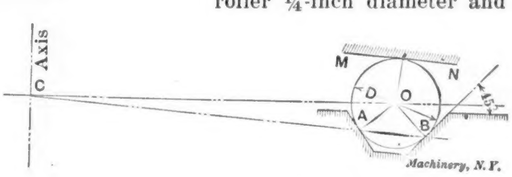


Fig. 4 Three-points Ball Bearing.

Diameter	Coefficient k	Diameter.	Coefficient k	Diameter.	Coefficient k
1/4	0.1	11/16	0.625	1 1/8	1.15
5/16	0.175	3/4	0.7	1 3/16	1.225
3/8	0.25	13/16	0.775	1 1/4	1.3
7/16	0.325	7/8	0.85	1 5/16	1.375
1/2	0.4	15/16	0.925	1 3/8	1.45
9/16	0.475	1	1.0	1 7/16	1.525
5/8	0.55	1 1/16	1.075	1 1/2	1.6

Washington, D. C. GEORGE LE GUERN.

A MARINE REPAIR JOB.

I wish to give some particulars of a marine repair job which may be interesting to a few of your readers. The high-pressure cylinder had broken at the top, a piece about 15 inches long and 5 inches deep being broken out and the cylinder wall fractured from one end of the break downward about 20 inches; the cover was also broken—leaving the flange on the studs.

The old liner, which extended up to the bottom of the steam port, was removed and a new one cast, being made the full length of the cylinder, with a flange at the top, as shown in

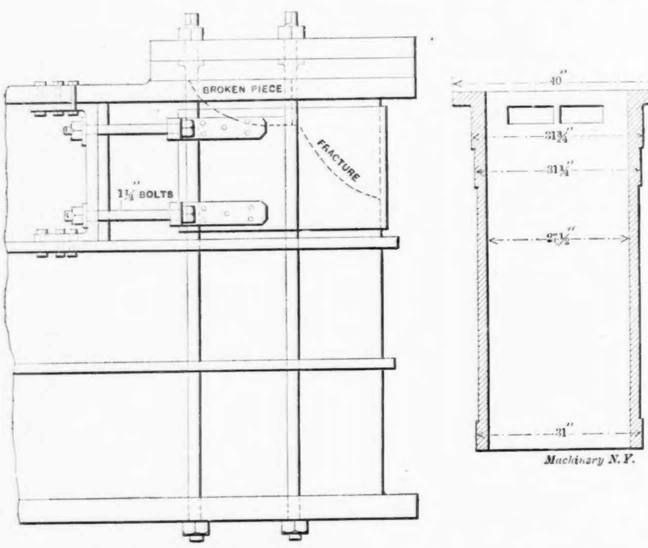


Fig. 1. General View of Repair Job and Section of Liner.

Fig. 1. New studs were made having a collar, as shown in Fig. 2, for which a corresponding counterbore was made in the stud holes in the liner. A square was left on the end of the studs, thus enabling them to be screwed tightly into the liner steam-tight, as the pressure carried was 200 pounds, liner and that of the cylinder. The liner was shrunk in, the cylinder being heated with steam. It was necessary to have the liner steam tight, as the pressure carried was 200 pounds, and if any leakage had occurred the broken wall of the cylinder would have had to bear the full pressure with obvious results. Above the top of the steam port the liner had only 2 inches of bearing surface, and as this was not considered sufficient to insure a good joint, two ¾ holes were drilled 2½ inches from each end of the port downward 1½ inch below the bottom of the port, a depth of 10 inches. Two copper dowels were then driven in tight and "staved up," so as to prevent any escaping steam from leaking round the fillet to the broken part.

In order to take the strain off the cover studs from the broken piece, two long bolts were used, one at each end of

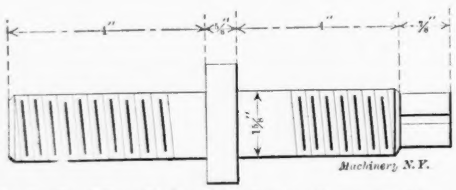


Fig. 2. Stud Provided with Collar for Fastening Liner

the break. They extended down through the bottom flange of the cylinder with nuts at each end and provided with a collar, the same as the studs. Two ⅞-inch studs were put through the broken piece and screwed into the liner, drawing the broken piece slightly up to the liner. A band made of 7/16 steel, 21½ inches wide, was placed round the top part of the cylinder and drawn tightly together by two 1¼ bolts, as shown in Fig. 1, the lugs on one side being bolted to the flange on the top and to a rib on the bottom. The job gave entire satisfaction and saved the large expense of making a new cylinder, which was first intended, not to speak of the delay to the steamer which that would have necessitated.

"Propellor."

A FEW "WRINKLES."

It is a mistake to suppose that "wrinkles" and methods already known, perhaps, to "old hands" or specialists, are without interest or value to the readers of engineering journals. Recruits are constantly being enrolled both in the engineering and machinists' trade, and also in the company of those who believe such journals instrumental in broadening their outlook on their vocation. Therefore I do not apologize for presenting the following matter, each item mentioned in which has been personally tested, if not actually originated, by me.

Collars of wrought or gray iron or steel, the bore of which from any cause has worn too large, or which on new work has been bored a "shade" too large, may often be made serviceable again by heating to red heat and allowing to cool slowly, repeating this process several times. It is really surprising sometimes to what an extent the bore may be reduced by this means. This feature has often to be taken into account in the design of steam boiler and other furnace grates, as the firebars, etc., "grow" in length or bulk by repeated heating and cooling, especially when fires are regularly banked.

The profitable all-round utility of bright drawn, round machinery steel (cold-rolled steel) is somewhat limited by the fact that it is generally supplied in sizes suitable for *revolving* in standard-sized holes. If a gear, collar, cam, or analogous article is desired to fit tightly, it must be bored smaller than standard size, which is an unprofitable process. This drawback may be completely removed by knurling with, say, a Pratt & Whitney knurling tool the part of the shaft or spindle where the tight fit is required, any degree of tightness of fit being easily obtainable. Oil should be used when pressing the article on the shaft or spindle. The appearance of the knurled part is not at all unpleasing. Another advantage of this method is that collars, gears, etc., which require fastening by taper pins at definite distances from each other—and still must be easily removable—may be tightly held while being drilled and reamed, and afterward the knurled portion of the shaft may be eased to give the exact push fit required. This is no "botch" job, as it fulfills any requirements for a good job, viz.: it looks well, acts well, and is cheaply produced. It has been used in hundreds of cases within my own knowledge, without a single failure or complaint being heard of.

The reaming of taper holes in mild or machine steel, tough bronze, etc., is, in the ordinary way, a somewhat tiresome and costly process, as the ordinary fluted reamer is liable to attempt to "bite off more than it can chew," thus coming to grief by breaking completely or losing its teeth by chipping. A certain amount of special pleading or tenderness in manipulation of the reamer is therefore called for. If, however, the taper reamer is made with two flutes only, after the manner of a twist drill, the flutes having a left-hand spiral, and backed off so as to cut right-handed, if a hole the size of the smallest end of the pin is first drilled through the work, a reamer of the style described may follow at the same setting of the job, and be used at drilling speed. In a particular case I can mention, since the employment of this type of reamer, the piece-work price has been reduced 50 per cent and the men can earn more money than previously.

James Vose.

* * *

While high-speed steel has proven itself to be of great usefulness for cutting tools of general description such as lathe and planer tools, milling cutters, reamers, etc., it has not as yet proven practicable to make such tools as taps, threading dies and chasers, which cannot be ground after hardening, of this material. The reason for this is that most grades of high-speed steel have to be heated to such a high temperature when hardening that the sharp edges of the tools to be hardened are practically melted away, and as a rule, unless the tool is of such a construction that it can be ground after hardening, it is almost useless for cutting purposes. It is not to be inferred from this that taps and threading dies are impossible to make from high-speed steel, but the difficulties encountered in trying to successfully harden these tools are such that prominent manufacturers hesitate to undertake the making of tools not possible to be ground after hardening from this material.

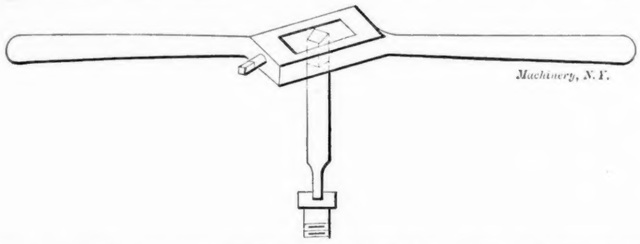
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

A HANDY SCREWDRIVER.

The accompanying cut shows a cheap, handy and very powerful screwdriver made out of a piece of tool steel. Flatten one end for the screw slot, either by forging, grinding, filing, or milling, and square the other end; harden and temper.

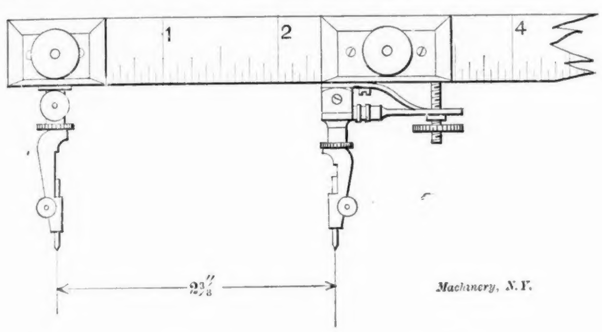


Use an ordinary tap wrench as a handle. Run the screw in with an ordinary screwdriver, and then tighten it with this tool, if the screw is large enough to require it. One can also use a monkey wrench or a dog on it, in an awkward place.

Beverly, Mass. CHARLES E. BURNS.

SCALE FOR BEAM COMPASS BAR.

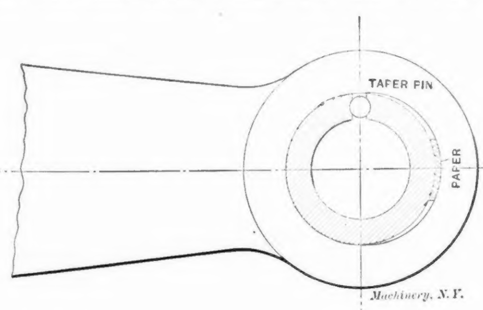
Beam compasses can be improved by placing a scale on the beam as shown. I had intended to purchase a paper scale engine divided in sixteenths and paste it on the beam, but finally decided that a linen tape measure would answer the purpose. There was no cost for this, as it was one furnished



by an advertiser, and on account of it being thin was better than could be bought. A coat of shellac keeps it clean and the divisions distinct. The object of the graduations is simply to get the pencil point approximately set, the finer adjustment then being made. WINAMAC.

TAKING UP WEAR IN A SOLID BUSHING.

After forcing the bushing out, I split it lengthwise with a hacksaw, cutting a slot about 1/16 inch wide; then I put two thicknesses of writing paper in the connecting-rod hole, on the side opposite to the pressure, clamped the bushing together, and slid it into the hole. Then I ran a taper reamer down into the slot, and drove a taper pin into it, very solidly; I

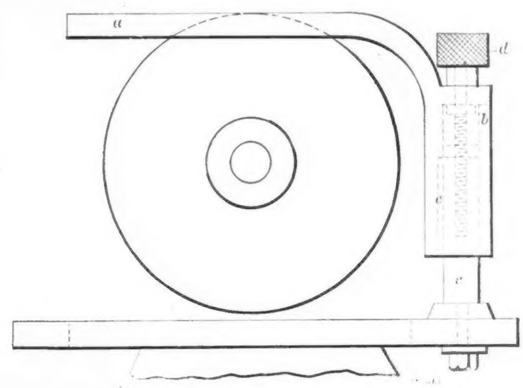


tried it in the arbor press and the bushing was a good pressing fit. The hole had been closed up just enough to be a good fit on the wristpin, and it also left a way open for future adjustments. The job has been in running condition five months already. CHARLES E. BURNS.

Beverly, Mass.

SURFACE GRINDING ATTACHMENT.

The cut shows a surface grinding attachment which can be used on any ordinary grinder and which I think is more handy than the one described in an article in the September issue of MACHINERY. Not every shop has a spare set of lathe legs as mentioned in that article. A stud with a nut and washer



holds this attachment to the slot provided on most grinders for holding the rest. The table *a* has a sleeve *b* on the lower side which slides on the post *c*. It is raised and lowered by the knurled head *d* of the adjusting screw. The key *e* prevents the table from turning on the post. H. K. G.

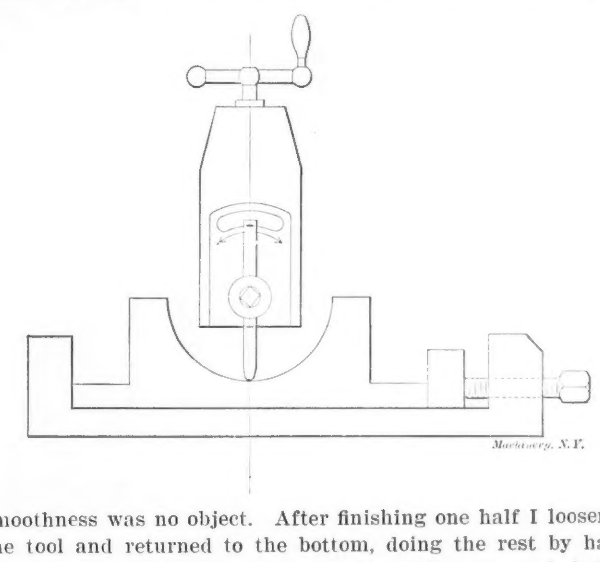
A SIMPLE SAFEGUARD FOR INK BOTTLES.

A very cheap and effective way of preventing ink bottles from being upset on the drawing table came to my notice recently. Simply cut a piece of card-board about 3 or 4 inches round or square, spread a thin coat of any good mucilage or liquid glue on the bottom of the bottle and set it in the center of the card-board. That's all. For the want of something more substantial, which is sometimes not to be had, this method does the trick very nicely.

Chicago, Ill. ROBT. A. LACHMANN.

PLANING AN ARC WITHOUT A RADIUS BAR.

There were some gray iron boxes and caps, which were too small in the bore to allow of sufficient babbitt metal between the shaft and the casting. To chuck them up in a lathe would have been expensive, so I placed them in the vise of a heavy shaper, and set a round-nosed tool with a long shank so that from the cutting edge to the center of the holder was the radius of the required boxes. Starting at the bottom, I fed from left to right by successive blows of a hammer on the shank, giving it all the cut the machine would pull, as



smoothness was no object. After finishing one half I loosened the tool and returned to the bottom, doing the rest by hammering the other side of the shank. This was much better than trying to start at one side and go the whole half circle, not only because the feeding would be more difficult, but greater inaccuracy would result if the tool shifted. This can be worked, when necessary, on a lathe without a compound rest. The trick is not new to many, but doubtless to the younger generation it will be. W. M.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas. It makes no difference if they are old and supposedly well-known, provided they have not already appeared in this department.

268. SOLDERING GALVANIZED IRON.

For soldering galvanized iron without scraping use raw muriatic acid. WM. DAVIS.

Philadelphia, Pa.

269. CEMENT FOR LEATHER.

One ounce shellac, 2 ounces pitch, 2 ounces linseed oil, 4 ounces caoutchouc, 1 pound gutta percha. Melt together and apply hot. E. H. MCCLINTOCK.

West Somerville, Mass.

270. NON-RUST SOLDERING SOLUTION.

A good anti-rust solution for soldering metals where acids must not be used, is made by dissolving rosin in acetone, making a solution about as thick as molasses; it is applied in the usual manner. W. R. BOWERS.

Birmingham, Eng.

271. TINNING WASH FOR BRASS WORK.

To prepare a tinning wash for brass work, use 6 pounds of white argil (potter's clay), 4 gallons of soft water, and 8 pounds tin shavings. Boil the brass work in this solution for 15 or 20 minutes. W. R. BOWERS.

Birmingham, Eng.

272. BLUING IRON OR STEEL.

Mix one part clean sand with one part powdered charcoal, heat the whole evenly in a pan or convenient receptacle until the piece, which has first received its finishing polish and been covered by the mixture, comes to the desired color. When cool, wipe dry with cloth. NERALCM.

273. ENAMEL GLAZE FOR COATING IRON PANS.

To prepare an enamel glaze for coating iron pans use flint glass, 130 parts; carbonate of soda, 20.5 parts; boracic acid, 12 parts. Dry at a temperature of 212 degrees and then heat to redness and anneal, that is, cool down very slowly.

Birmingham, Eng. W. R. BOWERS.

274. CEMENT FOR CAST IRON.

Mix 1 pound cast-iron filings, 1 ounce sulphur, and 2 ounces sal-ammoniac. Mix thoroughly and keep dry. When using, mix one part of this composition with twenty parts clear filings and some very fine sand. Make into a stiff paste with water. E. H. MCCLINTOCK.

West Somerville, Mass.

275. PRESERVATIVE OIL.

To make a preservative oil use high test grain alcohol and best grade of sperm oil, equal parts. Keep in a tightly-corked bottle, and shake well before using as the alcohol and oil separate after standing. Any moisture on a tool or gun at the time of application is quickly absorbed by the alcohol which in a short time evaporates, leaving a good coat of sperm oil to protect the surface from rust.

E. W. NORTON.

276. CEMENT FOR STEAM-PIPE JOINT.

A good cement for use in making steam-pipe joints is made in the following manner. Grind and wash in clean cold water 15 parts of chalk and 50 parts of graphite. Mix the two together thoroughly and allow to dry. When dry regrind to a fine powder, to which add 20 parts of ground litharge and mix to a stiff paste with 15 parts of boiled linseed oil. The preparation may be set aside for future use, as it will remain plastic for a long time if placed in a cool place. It is applied to the joint packing as any ordinary cement and will be found to last a very long time.

Olney, Ill. T. E. O'DONNELL.

277. ANNEALING STEEL.

Heat slowly or rather evenly to a dull red heat. Put it in a dark place or corner, box or barrel, until all signs of red have just disappeared, then quench in water, taking care to hold it still. When annealing flat stock, heat evenly and thoroughly, place between two planed pine boards on an ash heap and cover with ashes. By this method the charcoal is produced, so to say, automatically. WM. B. BROOKS.

New Kensington, Pa.

278. TO ANNEAL ZINC.

In working zinc the greatest loss is on account of the zinc cracking and being too brittle to handle to advantage. It is surprising to find how very few mechanics understand the annealing or malleablizing of same. The following will be found unfailing: Heat in oil to about 500 degrees F. and plunge in hot soda water, which works the double operation of drawing the zinc to the proper degree and at the same time cleanses the surface from the oil. HARDENER.

279. COLD SOLDER.

For flux use 1 part metallic sodium to 50 or 60 parts of mercury. These combine if well shaken in a bottle. For solder use a weak solution of copper sulphate, about 1 ounce sulphate to 1 quart of water; precipitate the copper by rods of zinc, wash the precipitate two or three times with hot water, drain off the water and add 6 or 7 ounces of mercury for every 3 ounces of precipitate. A trifle of sulphuric acid will assist in the combining of the matter. The combination will form a paste which sets very hard in a few hours.

New Haven, Conn. A. L. MONRAD.

280. TINNING CAST IRON.

To tin cast-iron articles, dissolve chloride of tin in water until the solution is fully saturated; this saturated solution is to be thinned down when needed for use, by ten times its volume of water. The articles which are to be tinned are to be wrapped around lightly with zinc sheet or wire and left in the solution ten to fifteen minutes. On removing the articles they are to be dried in sawdust, after washing well with clean water and brushing them with a wire brush, and then polished with prepared chalk. ROBERT GRIMSHAW.

Hannover, Germany.

281. RETOUCHING BLUEPRINTS.

An excellent solution for retouching or marking in details on blueprints can be prepared according to the following receipt. The solution consists of 75 grains of potassium oxalate dissolved in 1 ounce of water. If the solution is too thin and watery, it may be thickened by adding some kind of a gum preparation. It can be applied with a pen, as ordinary ink. The blue background is removed very rapidly by the solution, but it is important that the print is immediately washed, as the solution has a tendency to soak into the pores of the paper and blur the lines. T. E. O'DONNELL.

Olney, Ill.

282. TO PREPARE FINE ABRASIVE QUICKLY.

To quickly prepare fine abrasive use FFF emery or "15-minute" carborundum with benzine or naphtha for a liquid, mixing them in a square bottle. Use about two ounces of the abrasive to one quart of liquid; shake well and then lay the bottle flat on its side for the number of minutes wanted to settle; then pull the cork and let the liquid flow out until level with the cork hole bottom. The liquid just drawn off can be used at once with a brush, but by allowing it to stand for a time, the top portion can be poured off leaving the abrasive with a little benzine which will evaporate quickly, and leave the clear powder.

In explanation of the term 15-minute carborundum, would say that this is a term applied to fine abrasive obtained by the process just explained (manufacturers, of course, using watertanks instead of bottles), the time the liquid is allowed to stand, in minutes, being used to distinguish it. Thus, if it stands 15 minutes it will be known as 15-minute abrasive, etc.

SCOTTY.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

29. G. E. R.—Why is it that a stud and nut can be screwed up tighter than a tap-screw?

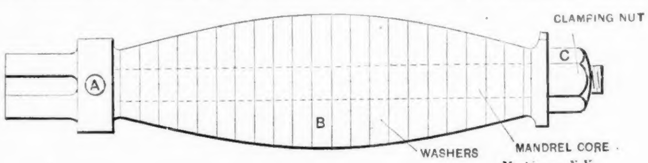
A.—We know of no good reason for such a condition existing; the effect of friction and torsional elasticity should be exactly the same in both cases. But lack of exact alignment, of course, affects a tap-screw more unfavorably than a stud and nut. It is true that a tap-screw will loosen quicker when subjected to vibration but this comes from the stud being screwed in until it shoulders on the tapered part of the thread while the tap-screw cannot be screwed to this point, hence is more easily jarred loose.

30. R. O. F.—What is the essential difference between the Willis and Walker system of cycloidal gearing?

A.—The Willis system is based on a single generating circle, the diameter of which is equal to the radius of the smallest gear in the interchangeable set. For example, suppose the Willis system is applied to a set of 3-inch circular-pitch gears, and it is desired that the smallest gear in the set shall have 15 teeth. Then the diameter of the generating circle will be 7.16 inches, which simply means that the faces and flanks of the teeth of the various gears will be shaped to conform with the curves generated by a point on a circle 7.16 inches diameter, rolling on the pitch circle of all the gears of the set. The Walker system is based on the same general principle as to using a rolling circle to generate the tooth shapes, but a single generating circle is discarded. Say the limits of an interchangeable set of Walker's gears are 10 and 200 teeth. Then the tooth shape is determined both with a 10-tooth and a 200-tooth generating circle, the tooth shape selected being a mean between the two for the faces or tooth parts above the pitch line; below the pitch line the flanks are shaped to the mean down to a certain depth and then the mean shape is departed from in order to give the necessary clearance for the top of the teeth for all the gears of the set. This system to a considerable degree overcomes the defect of under-cutting unavoidable with the Willis system on low-numbered gears, and is claimed to make a material improvement in the action in general.

31. A. L. M.—I wish to coil a few wire handles large in the center, similar to those used on stove-lid lifters. What kind of a mandrel is used for this work?

A.—Wire coils of this shape are manufactured on special wire coiling machines which require no mandrel, the coil being formed in mid-air, so to speak, by exterior rollers which automatically change position during the operation so as to



vary the diameter of the coil and thus make it of the required shape, *i. e.*, large at the center and small at the ends. For making a few such coils, however, you may use the form of mandrel shown in the cut, using it in an engine lathe in the usual manner. It consists of a number of thin steel washers mounted on a mandrel and turned to the required shape; they should be consecutively numbered so as to be readily replaced in order. The end of the wire is caught in the hole *A* made in the solid part of the mandrel, and the coiling is done on top of the washers *B*, the nut *C* keeping them close together. When the coil has been completed the removal of the nut allows the mandrel core to be removed and loosens the washers, which with a little rapping will fall out between the coils, if they be not too closely wound. This design of mandrel cannot be used for close wound coils unless very thin washers are employed. It is only recommended for experimental purposes and not for manufacturing.

32. A. L. B.—What is the use of a table of logarithms?

A.—A table of logarithms is of the same order of importance to the operations of multiplication and division that the multiplication table is to addition and subtraction. It is a great time-saver, and is practically indispensable for computation in which fractional powers are to be expanded, or fractional roots are to be extracted. For example, suppose the expansion of $189^{1.41}$ is required. The expansion is readily done by the use of a table of logarithms, but is impracticable by any other method within the reach or time of the ordinary calculator. Again, take such a calculation as finding the amount of $1.00 at compound interest for 50 years at 8 per cent semi-annually. This is an almost interminable operation, conducted in the primitive manner, but it is simple with logarithms. To illustrate we will work out the example. The primitive calculation requires that $1.04 (the amount of $1.00 at 8 per cent for 6 months) be multiplied by itself 100 times, but using logarithms makes only one multiplication necessary. The logarithm of 1.04 is 0.017033; multiplied by 100 it is 1.7033, or the logarithm of the amount of $1.00 for the given time and rate. The table discloses this to be 50.50. Hence the amount of $1.00 for the given time and rate is $50.50. To expand $189^{1.41}$ we simply find the logarithm of 189, and multiply it by 1.41. The logarithm of 189 is 2.276462, which multiplied by $1.41 = 3.209811$. Turning to the table it is found that 3.209811 is the logarithm of 1621.1, and this is the required expansion of $189^{1.41}$. By dividing the logarithm of 189 by 1.41 the 1.41st root is extracted, and so on.

* * *

SHORT LIFE OF MODERN HEAVY ORDNANCE.

The annual report of General Crozier, chief of ordnance, gives a startling idea of the short life of our 12-inch guns now in place in most of the coast fortifications of the United States. The report states that a 12-inch gun firing a projectile with a muzzle velocity of 2,500 feet per second will last for only about sixty rounds, after which the accuracy of fire is seriously impaired by erosion, which wears away and destroys the rifling. It is pointed out that the guns in any of the important fortified works of this country would last less than two hours in an engagement requiring rapid firing. General Crozier suggests that the caliber be increased to 14 inches and the velocity decreased from 2,500 feet to 2,150 feet per second, stating that the life of the gun is then increased to 200 rounds, and the penetration or smashing effect would be about the same.

The suggestion to reduce velocities and use larger calibers is one which we think will not be favorably received by military authorities in general. If it be considered that the life of a modern 12-inch gun firing projectiles with a velocity of 2,500 feet per second is only sixty rounds the situation is indeed serious, but high velocities and smaller calibers are the tendencies in both heavy ordnance and small arms. The thing to do is to find some material for lining high-powered guns which will not be affected by the incandescent powder gases as much as the steel now used. The suggestion has several times been made that high-speed steel is a material well adapted for such a purpose, inasmuch as it gains in hardness with an increase of temperature up to a low red and this is exactly what is wanted for the liner of a heavy rifled gun using smokeless powder. High-speed steel was developed in the manufacture of arms and armor and it would not be strange if it, itself, should become a necessary part of modern guns.

* * *

The substitution of machine steel for purposes for which carbon steel was formerly employed is one of the improvements about which little is heard. Nevertheless, some large concerns use it almost exclusively for dies, taps and other cutting tools which require toughness as well as hardness. A machine steel tap when skillfully casehardened will cut as freely and is said to wear practically as well as one of carbon steel. Besides being cheaper to make, it will not snap off suddenly when subjected to undue stress. We understand that the Singer Manufacturing Co. use little carbon steel in their Elizabethport works, and that all punches, dies, taps, etc., are generally made from machine steel, casehardened.

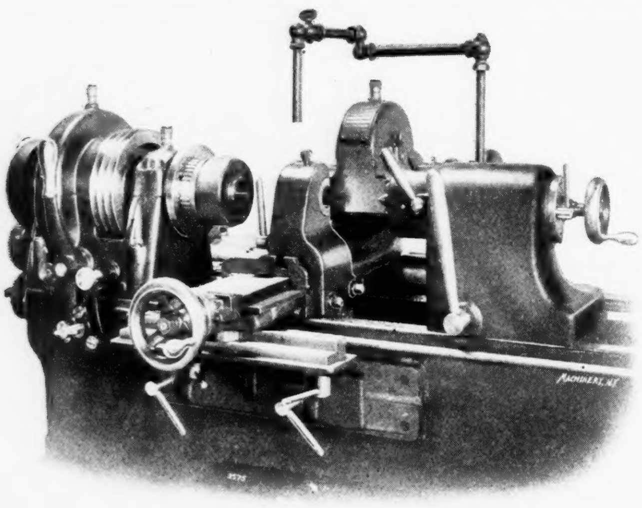
MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

TAPER ATTACHMENT FOR THREAD MILLER.

This attachment is designed, as shown in the cut, to be applied to the 6 x 48 Pratt & Whitney thread milling machine at the time the machine is built. In operation and general construction it is similar to the well-known Slate taper attachment for lathes. The taper bar is made in two parts, the one nearer the headstock being secured in a position parallel to the working centers, while the other is made adjustable to suit the required taper. This permits the threading of pieces which have both a taper and a straight portion. The bracket upon which the taper bar is mounted is attached to the front side of the bed in such a way that it may be shifted and clamped in any longitudinal position to agree with the location of the taper on the piece whose thread is being milled.

The cutter head is carried on a transverse slide to which is also attached the cross slide screw with its micrometer disk and positive stop, thus providing means for adjusting the position of the cutter for diameter of work and depth of cut in-



Taper Attachment for Thread Miller.

dependently of the mechanism of the taper attachment. The cross movement imparted by the tapered bar is communicated to the slide through the action of the positive shoe attached to it, held in contact with the front side of the taper bar, through the action of a roll under adjustable spring pressure on the rear side. The greatest angle to which the taper bar may be adjusted is 10 degrees, corresponding to about 4 inches taper per foot. All the required adjustments may be made without the use of a wrench. The Pratt & Whitney Co., Hartford, Conn., are the builders.

IMPROVED FOX TRIMMER.

The well-known universal trimmer made by the Fox Machine Co., 815-825 N. Front Street, Grand Rapids, Mich., has been redesigned and improved in a number of particulars. The rigidity and weight of the machine has been increased while its portability is still retained, it being mounted on three casters so that it may be easily shifted from place to place as required. A slight forward pull of the handle shown at the base of the machine in Fig. 1 raises it from its foundation onto the rollers, and the returning of the handle to the upright position settles it firmly on its base again. Other improvements relate to the means provided for taking up the wear of the cutter slide while still preserving the accuracy of the machine. Improved gages are also provided, both for angular cuts and straight work, while provisions are made for easily and accurately setting curved segments to bring the trimmed edge accurately radial and at the proper angle.

For plain angular work, the gages shown on the table in Fig. 1 are provided. A pivot block working through the curved slot in the table is fitted to the bottom of the gage by means of a carefully milled groove and tongue, and held by two heavy screws. The broad bottom of the gage rests flat on top of the bed of the machine while the pivot block underneath presents four carefully scraped and fitted bearings to the under side of the bed. This construction holds the gage rigidly. The pivot block has its center line directly on the

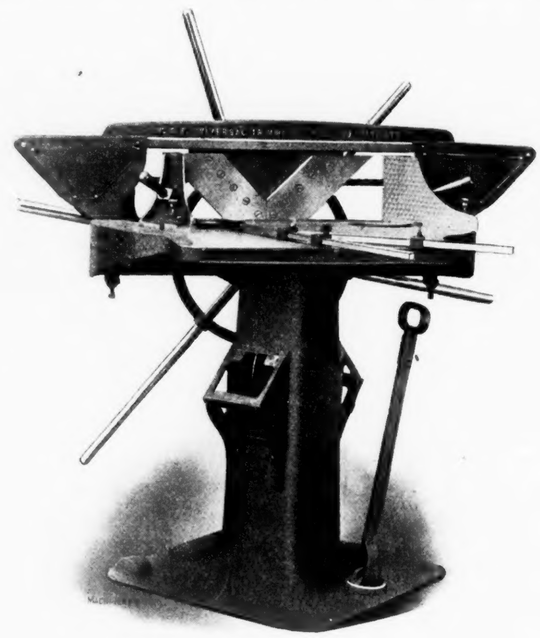


Fig. 1. Improved Fox Trimmer Front View.

spot where the cutting edge of the knife and the point of the gage meet, so that in swinging the gage, it is constrained to move in a true arc of a circle with the gage point always at exactly the same spot. This design does away with the inaccuracies which come from wear with the usual construction and hold it so rigidly that it is possible to set it with spring taper stop pins without locking it by the clamping lever. Even under these conditions a heavy cut may be taken

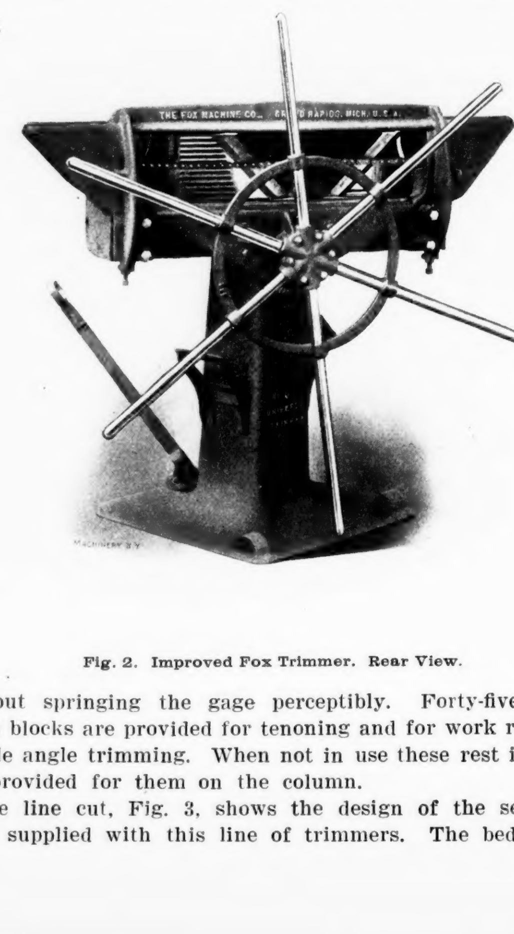


Fig. 2. Improved Fox Trimmer. Rear View.

without springing the gage perceptibly. Forty-five degree angle blocks are provided for tenoning and for work requiring double angle trimming. When not in use these rest in brackets provided for them on the column.

The line cut, Fig. 3, shows the design of the segmental gage supplied with this line of trimmers. The bed is laid

out for trimming segments of circles of 3, 4, 6, 8 and 12 segments to the circle, for diameters ranging from 6 to 95 inches. While universal trimmers have often been used on this work, hitherto close work has been impossible, the inaccuracy of the band sawing affecting the trimmed end. The new stop rod attachment shown limits this inaccuracy. The head which locates the outer end of the work can be pressed inward against the resistance of the spring mounted within it. In trimming the first end of the segment this head is pressed in. As the piece is reversed to finish the other end, the gage springs out again to the proper position for cutting the true angle on the other ends, the gaging being done from the already completed surface. The result of this is the elimination of the cut-and-try process in finishing the last piece.

Tabulated instruction plates are fastened to the knife guards at each side of the machine. That at the right hand contains a table giving the number of sides, center angles, angles between adjacent sides, radius of circumscribed circle, radius of inscribed circle and angle of setting for polygons of from 3 to 12 sides. Rules are also given for obtaining the length

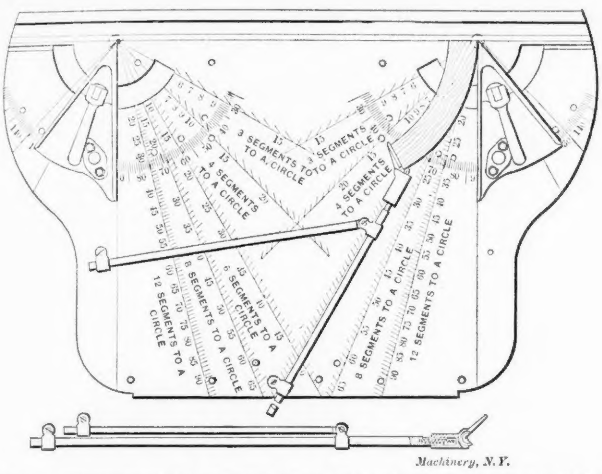


Fig. 3. Arrangement of Segment Gage Graduations on Surface of Table.

of a chord of a given segment. The other plate shows a graphic solution for finding the lengths of segments of a circle. This is intended to give the workman the number of degrees of a circle contained in a segment or triangle.

TWO NEW PRATT & WHITNEY PRODUCTS.

The Pratt & Whitney Co., Hartford, Conn., are now prepared to furnish their profiling machines in either the belt driven or spiral gear driven forms to suit the requirements or fancy of the purchaser. The use of belts is preferred to a spiral gear drive, as formerly provided, in cases where small cutters and excessive speeds are required. The No. 11 machine, for instance, when belt driven, may have as high a spindle speed as 2,500 to 3,000 revolutions per minute if the work requires it, thus adapting it to operations on the softer metals as well as iron and steel. The spindles are driven from a drum at the rear of the machine. The driving pulleys of the spindles are mounted on sleeves entirely independent of the spindle bearing. All the revolving parts including the drum and the pulleys are carefully balanced so that they may run at a high speed without vibration.

Another recent addition to the list of appliances made by this firm is a tool post grinder designed particularly for use with their bench lathe. The frame of this grinder is a steel casting with a shank of suitable form for holding in the regular tool post of the machine. The spindle is of tool steel, hardened and ground, with straight bearings running in bronze boxes, which are split, tapered on the outside and mounted in steel bushings with a nut at each end, by which the adjustment can be easily made to compensate for wear. The journals are thoroughly protected from grit and dust. The spindle has a tapered hole to receive the small arbors on which wheels for internal grinding are mounted, while the outside of the nose for the spindle is tapered to receive a wheel mount for external work. Oil for the spindle bearings is introduced at the rear end of the spindle, which is hollow and serves as a reservoir. When provided with small cutters on tapered sleeves this tool may also be used for light milling and drilling.

THE "JUST IT" LATHE TEST INDICATOR.

This little device is made by Mr. A. E. Babin, Waterbury, Conn., and is designed particularly for truing up work in the lathe, either from surfaces already finished or from prick

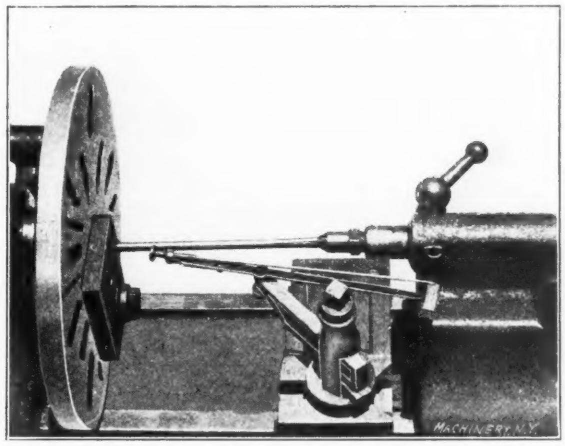


Fig. 1. The "Just It" Lathe Test Indicator Centering a Prick-punch Mark.

punch marks. Fig. 1 shows its use as a centering indicator. A bar is furnished having one pointed end and the other end centered. The pointed end is inserted in the prick punch mark of the work, while the centered extremity is held by the tailstock center, which is brought up to give it enough pressure to retain it firmly in place. The head of the indicator may then be brought against the end of the bar near the work and the error in setting found by noting the amplitude of the vibrations at the outer end of the needle. When used for truing a piece up from an exterior or interior surface, the end of the indicator is applied directly to the work.

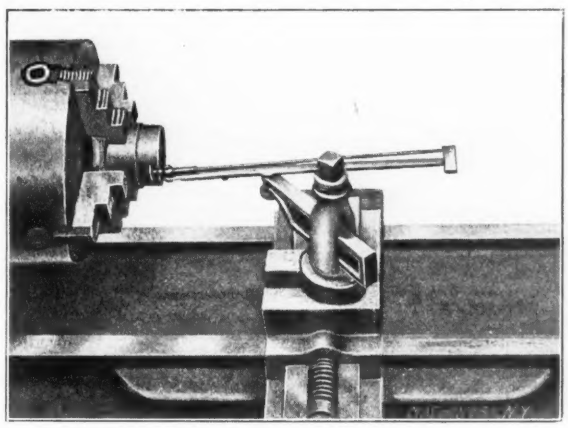


Fig. 2. The Indicator in use Truing the Outer Surface of Work Held in a Chuck.

The long distance from the head to the point where it is attached to the shank makes it very valuable for use with deep holes, as well as for work on the faceplate or planer where bolts and straps are used which would interfere with the ordinary indicating device.

HORIZONTAL BOILER RIVETER INSTALLATION.

The Chester B. Albree Iron Works Co., Allegheny, Pa., build a horizontal boiler riveter of a design different from the usual style in this country. The riveters employed in the boiler shops as a rule are vertically set machines, requiring a deep pit and high clearance for the crane overhead. In the design referred to above which is used to a great extent in Germany, the riveter is suspended horizontally from a trestle. The machine proper is supported by the trestle and is raised and lowered by means of a hand crane; a truck is provided for carrying the boiler back and forth during the riveting. On the top of this truck are placed six small rollers upon which the boiler rests during the riveting operation. These rollers are so arranged that the boiler may be rotated about its horizontal axis, thereby making it possible to bring any

part of its circumference under the riveting die. The manufacturers claim that this style of machine can be installed for half the price of a vertical stationary air compression riveter. The space saved by installing this style of apparatus may also, in many cases, be of importance.

THE FORTIN UNIVERSAL JIG.

The constant improvement taking place in the product of all manufacturing establishments means a constant change in the design and dimensions of the parts produced. Where these parts are made in such quantities as to warrant the use of jigs for the drilling, tapping, and reaming operations, this change in shape and dimensions involve a serious expense in the alterations thus made necessary in these tools. The B. P. Fortin Tool Co., Woonsocket, R. I., have designed and placed on the market a "universal jig," illustrated in the photographs and line cuts, Figs. 1 to 4: This tool is intended to be adapted to all ordinary work within its range, thus avoiding the necessity for a great number of jigs and the expense

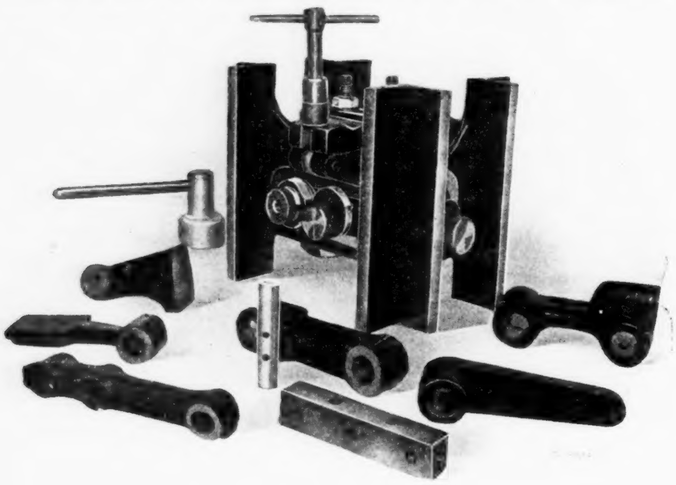


Fig. 1. The Fortin Universal Jig and Samples of Work.

of alterations and rebuilding consequent on changes in design, as described above. The main idea of the device is that of a rectangular box with a hinged cover. In each of the five sides, and the cover as well, slots are formed in which the required stops, clamping screws, locating surfaces, and drill bushings are fastened. In Fig. 1 the device is shown with its cover closed, and grouped about it is a collection of parts giving some idea of the variety of work to which it is adapted. Fig. 2 shows the jig tipped up with the cover open and a piece of work in place.

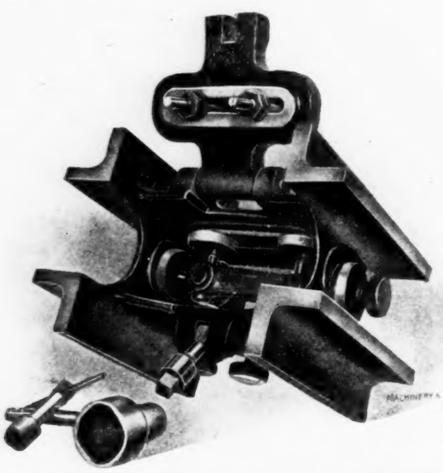


Fig. 2. The Jig with Cover Open and Work in Place.

The line cuts, Figs. 3 and 4, give a good idea of the design of the device. These cuts show two views of the jig as arranged in the halftone, Fig. 2. In Fig. 3, which is a horizontal section viewed from above, *A A A* are locating screws which form the abutment against which the work is clamped in a horizontal plane. These screws are provided with lock nuts and are threaded into bushings *B B B* which are clamped in slots in the side and end of the frame, as shown in the photograph. They are tightened by nuts *C C C*. As shown at *B* in Fig. 4, the holes in the bushings in which stop screws *A* are carried are eccentric, so that vertical and side adjustment for all of screws *A* is possible. Knurled clamped screw

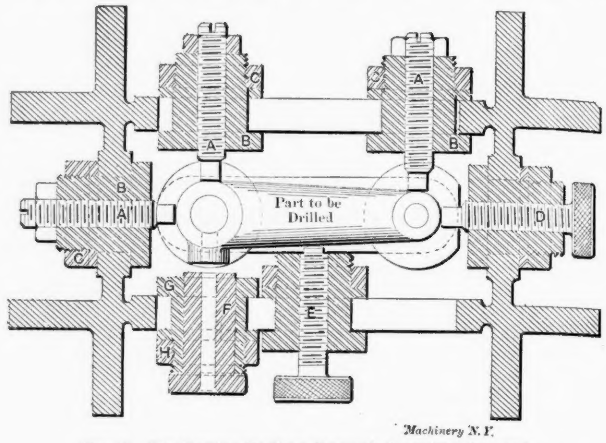


Fig. 3. Horizontal Section through Locating Screws.

D is carried in similar adjustable eccentric bushing in a slot at the other end of the frame. This screw holds the work against the left hand screw *A*, while a similar knurled head thumb screw *E* holds the casting against the back screws *A A*. Slip bushing *F* is carried by clamp bushings *G* and its nut *H* is carried by the front slot. This bushing may be removed to tap the hole after it has been drilled. So much for the holding devices and the jig bushings operating on the work in a horizontal plane. In a vertical plane, as shown in Fig. 4, the work rests on projections on the inner surface of drill bushings, *J J*, which are clamped by means before described in a slot in the body opposite the cover. Thumb screw *D* and stop screw *A* are those shown on the center line of Fig. 3. The cover *K*, which is mounted as shown in Fig. 2, carries in its slot two adjustable set screws *L L* held by lock nuts in the cover slot. The closing

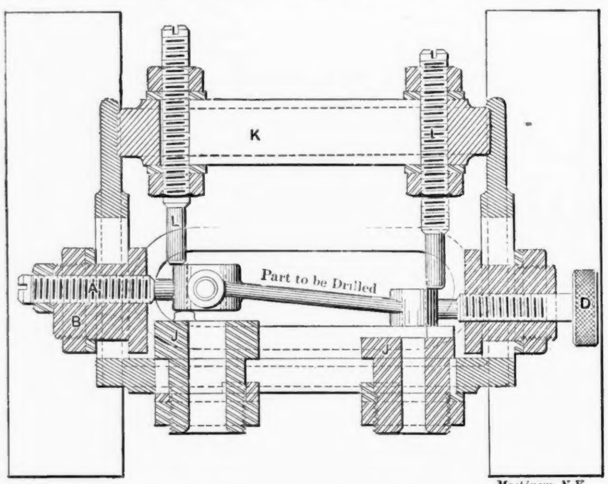


Fig. 4. Vertical Section through Cover Screws and Jig Bushings.

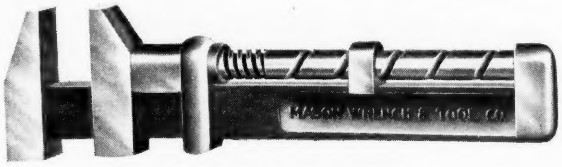
of the cover brings these down as shown on top of the work and the tightening of the cover nut with the key wrench shown in Fig. 1, in combination with the tightening of screws *D* and *E* in Fig. 3, fixes the position of the casting in relation to jig bushings *F* and *J J*. For holding round parts bushings *J J* with V-grooves formed in their inner faces are used.

In setting up the jig for a given piece, the location of the bushings is determined by inserting standard plugs in them, and taking measurements with micrometers or vernier calipers between the plugs themselves, and the surface plate on which the device rests, altering the adjustment until the correct location has been determined. After this has once been done a correctly made piece should be saved as a model; then, when the jig has to be set up again, the work may be placed within it and standard plugs used to bring the bushings in line with the holes in the model. The manufacturers state that this jig is the outgrowth of many years' experience on high grade jig and fixture designing. They call attention to

the ease with which it is adjusted and the accuracy of the work of which it is capable. The work may be placed in the jig and clamped in position as though it were specially designed for that particular piece. The bushings and gage points are all interchangeable. The device is made in eight sizes which will take in a complete range of work from 2 to 15 inches in length.

THE NOYES QUICK-ACTING WRENCH.

The most notable feature of the wrench shown below is the arrangement used for adjusting the jaws. A screw threaded in the jaw is used as usual. This screw, however, has a long body extending the full length of the handle and provided with a spiral groove of steep pitch. The sliding block or nut which engages this groove may be adjusted by hand to any position on the length of the handle. As it is moved its action on the spiral groove rotates the screw, which in turn

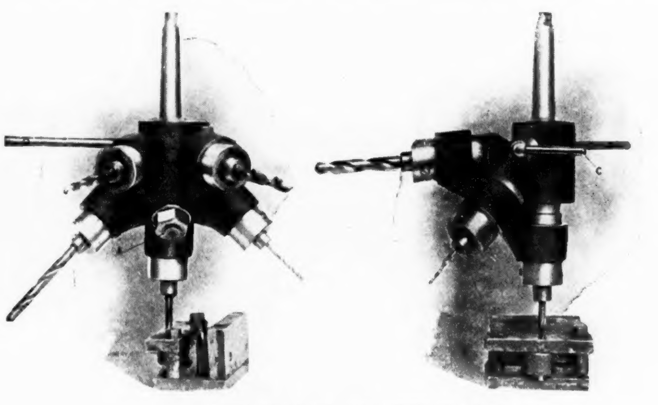


Noyes Quick-acting Wrench.

adjusts the movable jaw of the wrench. The pitches of the groove and the screw are so arranged that the mechanism is self-locking. This action is practically instantaneous since all that it is necessary to do to entirely close or entirely open the wrench is to slide the block from one extremity of its travel to the other. The makers, the Mason Wrench & Tool Co., First National Bank Building, Chicago, Ill., assert that special attention has been given to the strength of the tool, it having been designed to withstand any strain which may come upon it.

THE GEM TURRET HEAD FOR DRILL PRESS OR LATHE.

A five-tool turret head for the drill press or lathe in which only the tool in use revolves, is shown in the accompanying cut. To the inclined stud *A* is pivoted the revolving head *B*, carrying the five chucks for the tools. Handle *C* operates an eccentric which makes the connection between the revolving shank, driven from the spindle, and the tool chuck which is at the time in line with it. In the upper end of the chuck is milled a groove in which a hardened steel pin on the end of



Gem Turret Head for Drill Press or Lathe.

the shank is engaged. A tapered dowel in the center of the shank brings it and the chuck into perfect alignment. The bar *D* prevents the apparatus from turning as a whole.

The body of the turret is of gray iron, the spindle is of steel, the eccentric pin used in engaging the individual drills is of tool steel, suitably tempered. There are no springs or complicated clutch movements, and the drill working at the time is the only one that is in motion. Changes from one tool to another may be made almost instantaneously without stopping the drill press, regardless of the speed at which it is running. It may be applied to the spindle of a lathe for drilling work bolted to the carriage, or it may be held in the tailstock and take the place of a turret in finishing holes in work held in the chuck. This device is made by the Patterson Tool & Supply Co., Dayton, Ohio.

INDUSTRIAL NOTES FROM EUROPE.

Annealing and Hardening Furnace with Electrically Heated Liquid Bath, by L. M. Cohn, Berlin. The author gives a brief description of the processes in steel during annealing and hardening and deducts therefrom the conditions for a good annealing apparatus. Discussing the existing arrangements the author comes to the conclusion, that they by no means meet the requirements. Some afford the danger of changing the percentage of carbon in the steel; the obtaining of a uniform temperature depends to a great extent on the attendants; the temperature cannot be determined with sufficient accuracy; temperatures of up to 1,150 deg. C. (2,102 F.) as required for high-speed tools are only obtainable with one single type of furnace (electric hardening furnace by H. Craens, Hanau, Germany) and even there with difficulty; and temperatures of 1,300 degress C. (2,372 F.) as necessary for special steel tools for wholesale manufacture, and having to be of great strength, cannot be obtained at all.

The new furnace, designed and patented by Messrs. Gebr. Körting, Elektrizitäts G. m. b. H. Berlin, has a liquid bath heated by an electric current passing through it. The temperature of this bath is uniform throughout, except the uppermost layer, which may be considered as a sort of cover. The steel immersed in it is, therefore, heated uniformly in all parts. The temperature can be accurately measured and very easily adjusted to any temperature up to 1,300 degrees C. (2372 F.), and even higher still if required. The heating of the steel requires a comparatively shorter time than in other arrangements; waste or spoiled goods is exceptional; the percentage of carbon is not changed and the working is very economical.

The furnace consists mainly of a cast iron box, which is lined inside with fire-clay. Inside this lining is a second lining of fire-bricks, lined again with asbestos and inclosing the crucible made of one piece of fireproof material. The size of the crucible depends on the purpose the furnace is intended for. Two electrodes lead into the crucible, through which only alternating current has been sent, for avoiding electrolytical effects. The crucible is filled with metal salts, which in a cold state will not let electric current through, but are excellent conductors when molten. A special regulating transformer serves to regulate the current, and thus also the temperature. For temperatures above 1,000 degrees C. pure chloride of barium is used, the melting point of which is at about 950 degrees C. (1,742 F.); for lower temperatures a mixture of chloride of barium and chloride of potassium, 2 to 1 is used, melting at about 670 degrees C. (1238 F.). However, any other suitable salts may be used.

A test was made with a furnace, the bath of which was 6½ x 6½ x 7 inches. A 50-period alternating current of 190-volt primary tension was used. This tension had to be reduced to from 50 to 55 volts by the regulating transformer for starting the furnace, and lowered later on. The heating lasted about half an hour. For temperatures from 750 to 1,300 degrees C., the secondary tension amounted to from 13 to 18 volts. The consumption of energy was as follows:

Temperature in Deg. C.	Consumption of Energy, Kw.
880	5.4
1,140	8.5
1,300	12.25

A milling cutter 5 inches diameter, 1¼ inch bore, 1 inch thick, was heated in 62 seconds to 1,300 degrees C.

Another cutter 4½ inches diameter, 1¼ inch bore, ¾ inch thick, was heated in 55 seconds to 1,300 degrees C.

A bushing of ordinary tool steel 2¾ inches diameter, 2¾ inches long, ⅝ inch bore was heated in 243 seconds to 850 degrees C.

The two cutters had been previously heated in charcoal fire to a dark red heat, but the bushing had not.—*Elektrot. Z.* 1906, No. 31, Aug. 2, p. 721.

Some Grinding Machines exhibited by Naxos Union, Frankfort-on-Maine, at the Bavarian Jubilee and Lands Exhibition, Nuremberg, 1906:

No. 1. Grinder (German patent No. 247,711), with steel disks, covered with emery cloth or paper for accurately grinding small pieces of work.

No. 2. Grinder for edging heavy castings and forgings, plates, rolled iron, etc.; patent elastic, adjustable hinged guard (German patent No. 162,518).

No. 3. Direct electrically driven grinder for working heavy castings and forgings, edging plates, rolled iron, etc.

No. 4 Grinder (German patent No. 237,572) with revolving flexible shaft for grinding curved and molded round articles, which are stuck on the free end of the flexible shaft and thus rotated during work.

No. 5. Grinder with swiveling rest and direct electrical drive for wet grinding of profiled tools.

No. 6. Grinder with magnetic work table for smoothing thin articles, such as piston rings, etc.

No. 7. Grinder with planet-grinding spindle (circular motion of grinding spindle) (German patent No. 160,832), for grinding curved and straight links, grinding out sleeves and bores or large unwieldy parts or truing trunnions on the latter.

No. 8. Automatic twist drill grinder (German patent No. 166,460).

No. 9. Automatic saw grinder for circular and frame saws.

No. 10. Grinder with electrically driven grinding wheel for automatic grinding and polishing rolls.

Sewing Machine Industry.—This line has been very successful, the consequence being that several of the leading firms are contemplating extensions. Baer & Rempel, Bielefeld, have erected new large premises; Hengstenberg & Co., Bielefeld, are about to erect an annex; Dürkopp & Co., Bielefeld, are pushing the manufacture of sewing machines for special purposes; Siedel & Naumann, Dresden, are increasing their plant considerably, having put down a 1,000 horse power steam turbine, and are about to entirely reorganize their entire works; Clemens Müller, Dresden U., has erected a vast new building which he intends equipping next spring with new machine tools.

Electrical Engineering.—A new limited company has been founded as Elektrizitäts Gesellschaft Hochstrate & Böttcher Nachfolger, G. m. b. H., Witten, with the object of manufacturing and selling electrical machines and appliances. The capital invested amounts to $15,000.

Flexible Shafts for Cleaning Boiler Tubes.—Gustav Pickhard, Bonn, on Rhine, advertises his new flexible shafts for cleaning boiler tubes. These shafts consist merely of two or three closely wound wires, which thus form a very flexible, and yet strong spiral cable. These cables or shafts will not kink, and can be inserted to any depth into the boiler tubes. Tube cleaners, scrapers or brushes are attached to their end, and they allow of a great force being applied. They are supplied either in given lengths and then coupled together or they are supplied in one long piece. This causes no inconvenience whatever, as they are not heavy and are readily coiled up to a coil of comparatively small diameter. They vary from ¼ to ¾ inch outside diameter, the steel wires used being from 1-16 to ¼ inch thick. The prices vary from $1.75 to $12.50 per meter.

Suction Gas.—In a paper, "On the Development of Modern Suction Gas Plants," read before a special meeting of the Berlin branch of the Society of German Engineers, Chief Engineer Fritz Schleicher of the Gas Engine Works, Cologne-Deutz mentions a novel use of suction gas. The gas coming from the generator passes through the scrubber and purifier and through a fan producing the necessary action. Behind the fan the gas, which may be now termed pressure gas, is used to heat annealing furnaces, hardening furnaces and for soldering small parts. This novel use has been repeatedly and successfully employed in machine works for case-hardening parts of machines, in bicycles and motor car works, sewing machine works, etc., for hard soldering the various parts.

Iron Works Near Bremen.—A limited company has been formed by notable Bremen and Frankfort firms with a capital of $3,000,000, for preparing the establishment of large iron works. The chief products are to be pig-iron for export and foundry purposes, and steel for shipbuilding.

Grillo, Funko & Co., Gelsenkirchen, Westfalia, have leased a tract of land near the "Consolidation" pit, intending to erect there a plant for the manufacture of boiler tubes.

Berlin, Germany, November 15, 1906. D.

MISCELLANEOUS FOREIGN NOTES.

Craven Brothers, Ltd., Manchester, England, have lately redesigned their line of planers and have introduced two marked improvements in connection with this. On the smaller sizes there is a new cushioning device to prevent shock on reversal in high speed planing, and on the larger sizes there is a new system of main drive where the shifting belts are eliminated, although the drive still remains a belt drive.

A multiple drilling machine of a special design has recently been built by G. Swift, Halifax. It consists of five individual drill presses without tables mounted on a bed-plate 2 feet 6 inches high. The maximum distance between the spindles and the top of the table is 20 inches, the distance between the centers of the various spindles is 24 inches. The spindles are driven by direct gearing and will drill holes up to 1 inch in diameter. The driving arrangement is placed under the table or bed; this latter is 10 feet long by 3 feet wide.

D. Mitchell & Co., Ltd., Keighley, England, have placed on the market a new 4-foot radial drilling and tapping machine. The design is similar to that of ordinary radial drills, but there are some improvements in the driving and back gear arrangements. The drive may be either a 4-step cone driving the machine in the ordinary manner with or without back gears, or the machine may be supplied with a gear box and a single pulley drive. The arm is of pipe section and may be turned around to a complete circle; it is raised and lowered by means of worm gear and rack and pinion. The feeds obtained are 0.017, 0.011 and 0.006 inch per revolution of spindle. The bed of the machine is 2 feet 1 inch deep by 2 feet 3 inches wide and is provided with T-slots on the top and on the sides.

The firm of John Hetherington & Sons, Ltd., Manchester, England, has brought out a new high-speed radial drill. This machine is fitted either with self-contained motor drive or with countershaft drive, and is geared either directly to the spindle or by double or triple back gear arrangement. It is intended for use with high-speed steel drills. The radial arm has an adjustment through an arc of 180 degrees. The spindle has a diameter of 3 inches. The maximum distance from the base-plate to the spindle nose is 6 feet 2 inches, and the minimum distance is 4 feet 2 inches. The length of the radial arm from the center of the trunnion to the outer end is 7 feet 10 inches. The required floor space is 13 feet x 16 feet 3 inches. One smaller and two larger sizes of the same design are built by this firm.

In the first half of the year 1906 Scotland produced an amount of tonnage from her shipyards unprecedented in the history of shipbuilding. In these six months, according to a Glasgow dispatch, the shipyards put into the water no less than 207 vessels of all sizes, with an aggregate tonnage of 360,489. The nearest approach to that record was made in Scotland in 1902, when in six months 259,804 tons were produced. The large output from the Clyde yards was augmented by the launches of the *Lusitania*, a Cunard steamer of 32,500 tons, and the *Agamemnon*, a battleship of 16,500 tons, in the closing weeks of the half year.

The automobile and the motor omnibus have been considered in this country by many as more or less of a superfluous luxury. For this reason it is surprising to realize that the motor omnibus traffic in London reaches proportions far above what we generally conceive of. The motor omnibus in London carries in a year nearly 80,000,000 passengers which is considerably more than half the number of passengers carried by the New York subways. This fact is one of those which indicate the future of the automobile for other than recreation and racing purposes, and the automobile would fill its place and justify its existence far better if developed along such lines of general usefulness than along the lines of an expensive, and in many cases unnecessary, luxury.

SOCIETY FOR PROMOTION OF INDUSTRIAL EDUCATION.

In response to a call issued a month or two ago by a committee formed for the purpose, a party of manufacturers, educators, social workers and others interested in the project gathered at Cooper Union on the afternoon of the 16th of November, when the National Society for the Promotion of Industrial Education was organized and launched on what promises to be a thoroughly useful career. The objects of the society as expressed in the constitution adopted by that meeting are: "To bring to public attention the importance of industrial education as a factor in the industrial and educational development of the United States; to provide opportunities for the study and discussion of the various phases of the problem; to make available the results of experience in the field of industrial education both in this country and abroad; and to promote the establishment of institutions for industrial training."

The following officers were elected: President, Henry L. Pritchett, president of the Massachusetts Institute of Technology; vice-president, M. W. Alexander, General Electric Co., Lynn, Mass.; treasurer, V. Everit Macey, New York City. A board of managers consisting of twenty-seven members was also selected.

In an evening meeting of surprisingly large attendance, President Murray Butler of Columbia University presided, in the absence of President Pritchett, who was detained by ill health. This assemblage, in the crowded main hall of Cooper Union, was addressed by Dr. Butler, Frank G. Vanderlip, of the National City Bank, who spoke on the influence industrial education might play in our trade relations; Frederick P. Fish, president of the American Telephone & Telegraph Co., who discussed its effect upon citizenship; Alfred Moseley, whose speech related to American educational methods in general; Samuel B. Donnelly, secretary of the Building Trades Labor Association, who expressed the sympathy of organized labor with the aims of the new society; and, finally, Miss Jane Addams, of Hull House, Chicago. She dwelt upon the educational and moral side of the movement and expressed the hope that industrial education would lead to a greater satisfaction with life on the part of the workman, than was possible when he considered his work to be only a means of livelihood, without having for him any intrinsic interest.

According to the constitution adopted, all persons interested in industrial education are eligible to membership in any one of the four following classes: Members, paying annual dues of $2; sustaining members, paying annual dues of $25; life members, consisting of those who pay the sum of $250 or more; and honorary members, who are elected to that position by the unanimous vote of the board of directors, on account of having achieved "special distinction in promoting industrial education."

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PERSONAL.

Corneil Ridderhof, treasurer and general manager of the Wilmarth & Morman Co., Grand Rapids, Mich., has sold out his interest in that company. He will remain with the concern for the remainder of the year.

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FRESH FROM THE PRESS.

ANNUAL REPORT OF THE STATE GEOLOGIST OF NEW JERSEY FOR THE YEAR 1905. 338 pages, 6 x 9 inches. Illustrated. 3 maps. Copies can be obtained upon request. Address Mr. Henry B. Kummel, State Geologist, Trenton, N. J.

CAR INTERCHANGE MANUAL. Booklet form 3½ x 5¾ inches. 223 pages. Published by the McConway & Torley Co., Pittsburg, Pa. Price 25 cents.

This book is a companion of the Catechism of M. C. B. Rules and is devoted to abstract decisions of the Arbitration Committee of the Master Car Builders' Association. It contains abstracts of cases 1 to 703 inclusive. Some miscellaneous matter is added, giving monetary values of wooden cars; tables of words often misspelled on car reports; limits of tire wear for various types of steel-tired wheels, principles of levers, first aid to the injured, etc.

THE MECHANICAL WORLD POCKET DIARY AND YEAR BOOK FOR 1907. 247 pages (exclusive of advertising). 4 x 6 inches. Published by Emmott & Company, Limited, Manchester, England.

This is a small mechanical handbook, issued annually, containing the useful tables and formulas found in handbooks of this kind. It is particularly complete in regard to steam engineering, nearly 100 pages being given up to this subject. At the end of the book is a calendar for 1907 with more than 50 pages for memoranda. For general use this is a very handy little book well worth its cheap price which is only 25 cents in England, but if ordered from the United States the postage to this country must, of course, be added.

PRACTICAL ALTERNATING CURRENTS. By Newton Harrison. 375 pages, 5 x 7½ inches. 172 cuts. Published by W. L. Hedenberg Publishing Co., New York. Price $2.50.

This book is a practical treatise on the principles and application of alternating currents and is written in a delightfully easy style. Mr. Harrison is an author of rare ability in presenting a complex subject in a simple and entertaining manner. We know of no treatment on alternating currents and power transmission so well adapted to the needs of young electricians and others desirous of understanding the principles of the alternating current as this. The book is gotten up in pleasing style, well printed and is altogether a creditable effort in the field of technical publication.

CATECHISM OF THE M. C. B. RULES, 1906. Pamphlet form 3¼ x 6 inches, 40 pages. Published by McConway & Torley Co., Pittsburg, Pa.

The booklet is what the title indicates, being a résumé in the form of questions and answers of the important Master Car Builders' rules. It contains a number of illustrations, formulas, etc., and is well worth having by those interested in car construction and maintenance. Copies are sent free on request to those interested.

MACHINE DESIGN. By Charles L. Griffin. 184 pages, 6 x 8 inches. 82 cuts. Published by the American School of Correspondence, Chicago, Ill. Price $2.00.

This book forms part of the course of instruction in mechanical engineering of the American School of Correspondence and doubtless is one of the best treatises on practical machine design. It was warmly commended in these columns in the first review some years ago. It is strictly in sympathy with actual conditions which the machine designers have to meet, being written by a man well known for his sound mechanical judgment and practical common sense, who was, and is, closely in touch with the conditions surrounding the design and construction of machines. The work is well worth the attention of all machine designers.

TURNING AND BORING TAPERS. By Fred H. Colvin. Pamphlet form, 5½ x 8 inches. 25 pages. 22 cuts. Published by the Derry Collard Co., New York. Price 25 cents.

This booklet is No. 1 of a series of practical papers, and is a copy of the second edition. The determination of tapers and the setting of machines to produce them is a matter of practical importance to shopmen. It perhaps would not be far from the fact to say that there is no one other technical subject that interests a lathesman more than this, and a book which will tell him just how to measure or determine the proper setting for tapers and give him a comprehensive and correct idea of the subject as a whole, is of much intrinsic value. This little work undoubtedly fills the bill.

THE MACHINIST AND TOOLMAKER'S INSTRUCTOR. By Edward Genung. 264 pages, 4 x 6¾ inches, illustrated. Bound in "pocketbook" style with flap Sold by N. H. Covert, Beaver Falls, Pa. Price $3.00.

This book was published by Edward Genung in 1896 and, of course, is not a new book containing all the latest features of toolmaking and mechanical work which have been developed since that time. A great deal of the matter, however, is of a character that is always good and instructive for apprentices, mechanics and others requiring the information contained. The book treats of arithmetic; geometry; screw threads; trigonometrical tables; gearing, including spur, spiral, bevel and worm gearing; milling machines; principles of mechanics; screw-cutting, steel working, etc. Many will doubtless find it of much practical value in their everyday work.

AIR COMPRESSORS AND BLOWING ENGINES. By Chas. H. Innes. 290 pages, 4¾ x 7 inches, 285 cuts. Published in the United States by the D. Van Nostrand Co., New York. Price $2.00.

This book is specially intended for mechanical engineers taking up the theoretical as well as the practical sides of the subject. The first chapter treats of the physical properties of air, following which are chapters on experiments with compressors; valves for producing equalization of pressure; blowing engines; and air compressors. The theoretical chapter on the physical properties of air is of considerable extent, but without use of the higher mathematics. The general descriptive part has reference, of course, to British types of machinery. The illustrations are mostly line cuts and reproductions of wood engravings. These are not very well executed, but the book as a whole is of considerable value to those interested.

TEXT-BOOK ON THE STRENGTH OF MATERIALS. By S. E. Slocum and E. L. Hancock. 236 pages, 6 x 9 inches. 170 illustrations. Published by Ginn & Co., Boston, New York and Chicago. Price, $2.00; by mail, $2.15.

The subject matter of this book has been divided into two parts: the first presenting the theoretical side of the strength of materials and the second the experimental side. This was done to provide for the needs of both the classroom and the laboratory. As might be expected, the theoretical side of the subject is rigidly mathematical, using the calculus for the deductions. Part 2, or the experimental part of the book, treats of the properties of iron and steel, lime, cement and concrete, reinforced concrete, brick and building stone, timber, rope, wire and belting. An excellent feature of the mathematical part of the book is the insertion of numerous problems to be worked out by the student. The answers are given in the back of the book.

MARINE ENGINEERS; THEIR QUALIFICATIONS AND DUTIES. By E. G. Constantine. 332 pages, 4¾ x 7 inches. 84 cuts. Published in the United States by D. Van Nostrand Co., New York. Price $2.00.

As indicated by the title this work is of the practical duties of marine engineers, giving an idea of what the nature of a marine engineer's duties are; what the requirements are as to education and training, term of apprenticeship, etc. The work takes up the history of the marine engine and its development; it treats of boilers and boiler management; and in addition gives copious notes on the Board of Trade examinations which must be passed in Great Britain in order to get an engineer's certificate. The book is interestingly written and presumably reliable in its statements. The work, of course, is strictly British in tone and the technical requirements laid down are those affecting British commerce and do not necessarily apply to the requirements for American marine engineers.

METALLURGY OF CAST IRON. By Thomas D. West. 627 pages 4¾ x 7¼. 153 cuts. Published by the Cleveland Printing Co., Cleveland, Ohio, and sold by the David Williams Co., New York City. Price $3.00.

This well-known work now appears in the eleventh edition. The wide sale it has had is an indication of its worth to foundrymen and foundry chemists. The conditions of foundry practice have undergone a great change within the past twenty years; the old-time method of mixing depending on the judgment of the cupola charger has been largely superseded by the more intelligent and reliable practice of charging according to analyses. It is a consummation for which Mr. West has worked diligently, and to his efforts in a large measure, no doubt, is the improvement in present American foundry practice due. The book is a standard treatise on the metallurgy of cast iron and should be in the hands of every practical foundryman who expects to make a success of his business.

CONTENTS FOR DECEMBER.

American Stationary Engineering. By W. E. Crane. 285 pages, $5\frac{1}{2} \times 7\frac{1}{2}$ inches. 107 cuts and diagrams. Published by the Derry Collard Co., New York. Price $2.00.

This book is intended for the engineer and fireman of power plants and the mechanical engineer as well. It is strictly practical in every respect, containing just such information as many are looking for but which is contained in few available works. The book treats of the boiler room; boiler feeding, pumps for boiler feeding; scale in boilers; boiler cleaning; strainers; strength of boilers; boiler settings and fittings; boiler explosions; taking care of expansion; main steam pipes; steam heating; mason work; making cements; pile driving; brick and steel chimneys; the engine room; balancing engines; lining engines; bushing cylinders, piston rods; hot boxes; Corliss engines; air pumps and condensers; tools for the engine room; belting, horse-power, belts; oils; cleaning; compression lap and lead; steam pumps; safety valve calculations; pop valves; estimating water power; examination questions, etc. It is one of the few books that can be conscientiously recommended to engineers, firemen and others requiring sound instruction on the essential principles and practices of stationary engineering.

NEW TRADE LITERATURE.

Rockford Machine Tool Co., Rockford, Ill. Circular describing and illustrating the 20-inch Rockford shaper.

The Graham Mfg. Co., Providence, R. I. Leaflet describing the Graham drill speeder, telling some things it will do and giving dimensions.

W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill. Catalogue No. 61 treating of upright drills and other machine tools. These machines are illustrated and such description as is necessary is given.

Gisholt Machine Co., 1316 Washington Avenue, Madison, Wis. Leaflet illustrating a method employed by this company for finishing an automobile flywheel.

Joseph Dixon Crucible Co., Jersey City, N. J. Pamphlet of Dixon's motor lubricants. Lists and describes the various graphite lubricants and pointing out advantages of same.

The Pittsburg Automatic Vise & Tool Co., Pittsburg, Pa. Illustrated catalogue descriptive of the Pittsburg automatic two-way vises, a departure from former vise construction.

The Fairbanks Co., Springfield, Ohio. Catalogue No. 6 of "United States" tool-holders describing new lathe, planer and shaper tools including turning, threading, side, boring and cutting-off tools.

Franklin Mfg. Co., 203 South Geddes St., Syracuse, N. Y. Booklet showing the possibilities of the Franklin die cast process. Illustrations of the different styles of finished castings produced by this die cast method are shown.

The John M. Rogers Works, Gloucester City, N. J. Pamphlet of high-speed reamers containing illustrations and specifications of various types of reamers, all of which are fitted with high-speed steel blades.

Buckeye Engine Co., Salem, O. Catalogue of Buckeye electric blue-printing machine. A complete description of the construction of this machine is given as well as prices of and directions for operating same.

The Cincinnati Ball Crank Co., 1644-46 Central Avenue, Cincinnati, O. Pamphlet illustrating and giving specifications for steel ball crank machine handles, compound rest handles, machine handles and two-ball levers.

Narragansett Machine Co., Providence, R. I. Locker catalogue listing and illustrating their standard sizes of lockers. It is the aim of the company to produce a high grade steel locker, and special care is given to details, as will be seen by the illustrations on pages 4 to 7.

Norton Grinding Co., Worcester, Mass. Catalogue of Norton plain machines for cylindrical grinding. Specifications and excellent half-tone engravings of the different machines are given. Following the introduction are brief descriptions of the various parts of the machines and a list of their points of superiority.

Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. Catalogue Section A describing "cold process" automatic nut bolt rivet machinery. The several styles of headers have been improved and redesigned throughout and now possess greater strength, durability, speed, ease of operation and adjustment.

Hammacher, Schlemmer & Co., 4th Avenue and 13th Street, New York. Catalogue No. 310 on high-grade woodworking tools in sets. This includes tool outfits for home use as well as for the trades. The special feature of these outfits is the quality of the tools, only those of high grade being included. Price lists and illustrations of several of the outfits are given.

L. H. Gilmer & Co., Philadelphia, Pa. Report of test made of Gilmer endless belts at the Springfield Armory. The test demonstrated that the Gilmer endless belt is superior to leather belts for use on machines having pulleys of small diameter inasmuch as it is less liable to stretch, is light and the joint is of the same thickness as the remainder of the belt.

Ingersoll-Rand Co., 11 Broadway, New York. Bulletin No. 2008, Imperial hoists and stationary motors, gives a complete description of the Imperial motor hoist with illustrations and tables of sizes and dimensions. The Imperial stationary motor, also described, is a small motor of the standard Imperial type designed for all purposes requiring a small but powerful engine for intermittent service. Illustrated part lists of each machine are also included. Bulletin No. 2011, the "Little Jap" hammer drill discusses fully the construction, operation and advantages of this tool.

Joseph Dixon Crucible Co., Jersey City, N. J. The tenth edition of "Graphite as a Lubricant. The subject of lubrication in general, and graphite lubrication in particular, is exhaustively treated. All the good features of the previous edition are retained, but the very latest information—both scientific and practical—that has to do with the subject is added, making it valuable to the student of theory and the man of practice. The publication is arranged and indexed so as to readily enable the reader to find the information he is most interested in. Those who desire to post themselves on better lubrication should secure a copy.

The Western Electric Co., Chicago, Ill. Booklet entitled "Hawthorne Works," being a general description of the Western Electric Co.'s plant at Hawthorne, Ill., which was described in Machinery, for July, 1906. This plant is erected at the extreme west of the city of Chicago, a tract of 110 acres having been purchased five years ago for it and to which more land has since been added. The plant is modern in every respect. The machine shop is 860 feet long, 130 feet wide and is equipped with up-to-date tools for the manufacture of electrical apparatus. The company put special stress on the fact that they are in position to build heavy electrical apparatus and have all the facilities for such work.

The Cincinnati Milling Machine Co., Cincinnati, Ohio. "Examples of Rapid Milling," being an illustrated pamphlet containing sixty illustrations of work done on the Cincinnati milling machine, taken from actual practice. Each example is a half-tone illustration showing the work, the machine, cutters and fixture or jig used for holding the work. One page is given up to each example and data are given, showing the nature of the job, size of cutter, speed in revolutions per minute, surface speed and feed. The pamphlet is a valuable contribution to technical literature, giving data on milling machine production of much value. Needless to say it is an effective argument for the milling machine on the class of work illustrated.

The American Locomotive Co., 111 Broadway, New York, have just published a pamphlet "Consolidation Type Freight Locomotives" describing consolidation locomotives weighing more than 175,000 pounds. It is a companion to the one issued in October presenting the design of this type weighing less than 175,000 pounds. Twenty-eight consolidation locomotives built for various railroads and ranging from 175,000 pounds to 250,000 pounds are illustrated and the principal dimensions of each given. The series now covers the Atlantic, Pacific and Consolidation types and copies of any or all of these pamphlets will be sent upon request.

B. F. Sturtevant Co., Hyde Park, Mass. Catalogue No. 140 on Sturtevant high-pressure blowers. This catalogue is one of the Sturtevant engineering series, and is gotten up with a view of not only advertising the Sturtevant, high-pressure blower, but of also presenting engineering data of value on the movement of air by blowers. It describes in detail the Sturtevant high-pressure blower which was described in the February, 1906, issue of Machinery and gives data on diameters of blast pipes, data of value to foundrymen regarding the composition of pig-iron, composition of resulting iron, etc. It also gives a chapter on the construction of the Sturtevant vertical engine. The concluding chapter on testing blowers is of much technical interest and value, giving formulas for determining the volume of air and tables and diagrams determining the weight per cubic foot of dry air under different pressures and temperatures, the flow of air through orifices, etc. It is altogether a most attractive, interesting and valuable catalogue.

The Committee of Manufacturers, 21 William Street, New York City, has sent us a copy of regulations No. 30 U. S. Internal Revenue, entitled "Regulations and Instructions concerning Denatured Alcohol." The law passed by Congress last winter relieving properly denatured alcohol of the internal revenue tax opens up a large field for its use in the arts, and the regulations and instructions concerning denaturing alcohol are of importance to those who intend to enter into manufacture requiring its use. A completely denatured alcohol consists of 100 parts ethyl or grain alcohol (not less than 180 degrees proof or 90 per cent pure), 10 parts methyl or wood alcohol, and ½ part of benzine. Other denaturing substances for alcohol users who cannot use a mixture of grain and wood alcohol, will be taken up in the near future by the Internal Revenue Bureau. The spirit of the law was to render the preparation of denatured alcohol cheap, but the restrictions surrounding it seem to us to favor a distillery trust and to tend in a measure to defeat the aim. However, the matter is a difficult one to handle, and perhaps the prescribed Government regulations are all strictly necessary.